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LEVEL II

CARDIOVASCULAR LABORATORY POLICIES AND PROCEDURES

Ross Lee Cook, Major, USAF, NC

December 1978

Final Report for Period December 1976 - December 1978

USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235

NOTICES

This final report was submitted by personnel of the Internal Medicine Branch, Clinical Sciences Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, under job order 7755-16-02.

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This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In this report ~~(which supersedes SAM-TR-75-39)~~, the team approach to the care of the cardiac catheterization patient is emphasized, and the team members' respective responsibilities in various stages of care are specified. Care of the patient before, during, and after a catheterization procedure is presented. Aseptic techniques, environmental controls, electrical, and radiation safety are discussed, as well as guidelines for optimal patient care and safety.

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20. ABSTRACT (Continued)

The lists of supplies and equipment used in the laboratory include information about various cardiac catheters. Procedures for the loading and use of automatic computerized injectors are outlined. Cardiac output is discussed, along with two methods of determination used in the laboratory.

PREFACE

The purpose of this publication is to provide guidance and direction to personnel assigned to the Cardiovascular Laboratory, Internal Medicine Branch, Clinical Sciences Division, of the USAF School of Aerospace Medicine. The text should be useful in the orientation of newly assigned people, and will also afford day-by-day operational guidelines. Detailed information on the personnel, procedure, and logistic capabilities of the Laboratory is presented, as well as measures utilized for environmental controls. (This technical report supersedes previous editions, such as SAM-TR-75-39: Basic Organization of the Cardiovascular Laboratory, by Dr. A. J. Thompson and Dr. Victor F. Froelicher.)

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CARDIOVASCULAR LABORATORY POLICIES AND PROCEDURES

INTRODUCTION

Philosophy

The operation of the cardiovascular laboratory is based on the philosophy that it is an important element in the complete aeromedical evaluation of selected aircrewmen which is performed through the Aeromedical Consultation Service of the USAF School of Aerospace Medicine (USAFSAM). This philosophy includes a belief, not only in the holistic nature of man, but also in the policy that safety and welfare of the aircrewmen examined here are the primary concerns of the cardiac catheterization team, and that the airmen who undergo cardiac catheterization are intelligent, self-determining individuals with the right to:

1. Receive complete explanations regarding procedures, facilities, and personnel
2. Provide informed consent for proposed procedures
3. Have privacy
4. Expect safety
5. Receive disclosure of test findings
6. Participate in the planning of any recommended life-style modifications

Goals

For the aircrewmen who undergo cardiac catheterization, the staff of the cardiovascular laboratory has certain goals:

1. The successful completion of cardiac catheterization
2. The uncomplicated departure from the Nursing Unit
3. The uncomplicated return to duty
4. The promotion of optimum cardiac function and acceptable quality of life

THE CARDIAC CATHETERIZATION TEAM

The Team Concept in the Cardiovascular Laboratory

For optimum subject welfare and efficiency of operation, cardiac catheterization personnel must function as a team. The team is composed of both professional and paraprofessional members who must understand thoroughly the procedures performed in the laboratory, know their individual responsibilities, and work together as a unit. The professional team members are the cardiologist, who is the team leader, and the cardiovascular nurse. The paraprofessional members are the cardiopulmonary, electronics, and x-ray technicians. For Fick output studies, a pulmonary technician is also a member of the team. Each team member has specific functions which are vital to the successful completion of a cardiac catheterization (cath). Each team member should also understand as much as possible about the functions of the others in order to be able to assist and/or fill in, should the need arise (1, 16, 36).

The person being catheterized must be the focus of attention, and any distracting influence must be prevented in order to assure optimal safety. The laboratory is not the place for competition or personality conflicts. If interpersonal problems arise, they should be handled outside of the laboratory. A monthly team meeting should be held for the purpose of reviewing procedures and policies, for discussing problems, and for improving methods of operation. Each afternoon before a catheterization, a brief team meeting should be held to review the impending procedure. These meetings contribute to the stability of the team and eliminate uncertainty or confusion during the procedures. The following organization chart (Fig. 1) demonstrates the position of the cardiovascular laboratory team in relation to the Internal Medicine Branch at the USAF School of Aerospace Medicine.

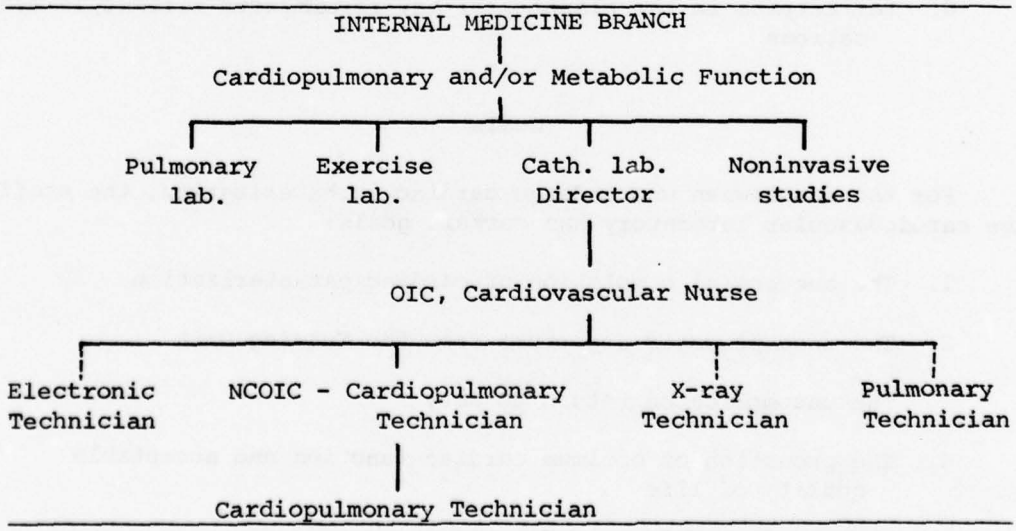


Figure 1. Organization chart. [OIC = Officer in Charge; NCOIC = Noncommissioned Officer in Charge.]

The Cardiologist's Responsibilities

One cardiologist is the Director of the Cardiac Catheterization Laboratory, but each physician performing catheterizations has certain responsibilities to each of his patients, and to the functioning of the cath team as team leader (3). The cardiologist's responsibilities include the periods before, during, and after the catheterization:

Precatheterization period--

1. Discuss the reasons the procedures are indicated and goals of the procedures with the patient.
2. Describe the planned procedures in layman's terms, with a thorough discussion of potential complications and risks. Specific areas of potential risk and complications are presented in Form 1 (in Appendix A).
3. Obtain an adequate medical history and perform a physical examination.
4. Review pertinent precatheterization laboratory data and diagnostic studies.
5. Write precatheterization orders and a precatheterization note outlining pertinent history, physical findings, anticipated catheterization procedures, and laboratory data.
6. Inform the nurse of the impending procedure and introduce the patient to the nurse, if at all possible.
7. Preside over a team meeting, the day before the procedure, and discuss: the reasons for doing the case, type(s) of catheterization to be done, equipment or special supplies needed, and possible problems to watch for.

During the cardiac catheterization procedures--

1. Supervise the individuals participating in the procedures.
2. Perform the various catheterization procedures, and make the decision whether to proceed or discontinue procedures.
3. Prescribe appropriate medications or other forms of therapy during the procedure.
4. Make certain that adequate hemostasis has been obtained before the patient is transferred from the catheterization laboratory.

Postcatheterization period--

1. Write appropriate postcatheterization orders.
2. Review the catheterization data and record it appropriately. (A catheterization report is subsequently dictated.)

3. Discuss fully, with the patient, the results of the catheterization procedures.
4. Examine the catheterization site prior to the patient's discharge, and instruct him in the care of the incisions.

The Cardiovascular Nurse's Responsibilities

The Cardiovascular (Cardiopulmonary) Nurse is responsible for supervising the overall functioning of the catheterization lab, and works with the cardiologist-director and chief nurse of the branch to insure smooth operation (32, 49). The Cardiovascular Nurse is responsible for the maintenance of environmental and quality controls relative to the lab. (See Form 2, in Appendix A, for her specific position description.) The Cardiovascular Nurse seeks to insure a continuity of care for each patient from the time he decides to have a cardiac catheterization performed until he is discharged from the Nursing Unit following the procedure.

As part of the cardiac catheterization team, the Cardiovascular Nurse's functions include, but are not limited to, the periods before, during, and after the catheterization:

Day before the procedure (19, 53)--

1. Interview the patient:
   a. Establish rapport and confidence (51).
   b. Accomplish precath teaching and reinforcement of the cardiologist's explanations and instructions.
   c. Obtain and witness informed consent for the procedure (Form 3, in Appendix A).
   d. Obtain risk factor and allergy data.

2. Obtain the patient's record from the Flight Medicine Branch, and review it for completeness and any significant test findings.

3. Initiate record (for Forms 4-7, refer to Appendix A):
   a. Cardiovascular Laboratory Patient Flow Sheet (Form 4).
   b. Cardiac Catheterization Risk Form (Form 5).
   c. Cardiac Catheterization Record (Form 6).
   d. Framingham Risk Predictor Form--History and P.E. (Form 7).

4. Order precatheterization blood work.

5. Insure that notification regarding the catheterization is given to all concerned:
   a. Cath Team Members.
   b. Nursing Unit Personnel.
   c. Clinical Laboratory.
   d. Dietitian.

6. Secure aeromedical clearance for the procedure from the Chief, Flight Medicine Branch.

7. Check all emergency equipment, routine and emergency drugs, and solutions.

Day of the procedure (20, 26, 28, 33, 64)--

1. Check emergency equipment.
2. Supervise the preparation of the lab for the procedure.
3. Prepare routine and emergency drugs and solutions.
4. Supervise the patient's preparation for the procedure, considering his holistic needs.
5. Monitor aseptic technique throughout the procedure.
6. Closely observe the patient throughout the procedure and advise the cardiologist of any changes.
7. Administer and record the use of medications.
8. Maintain the "Patient Flow Sheet."
9. Supervise the transfer of the patient from the laboratory to the Nursing Unit.

The postcatheterization care of the patient is discussed in the section on "Cardiac Catheterization: Preparation and Procedure."

The NCOIC/Charge Technician/Circulating Technician's Responsibilities

The job description of the NCOIC of the Cardiovascular Laboratory is available in Form 8 (in Appendix A). The responsibilities of the NCOIC, who functions as the circulating technician member of the cath team, are the following:

Day before the procedure--

1. Orient the patient to the lab the day prior to procedure.
2. Check with the cardiologist regarding which catheters will be desired for use.
3. Secure the patient's chest film from the x-ray department.

Day of the procedure--

1. Provide sterile supplies to the sterile team members.
2. Monitor aseptic technique.
3. Help prepare the patient for the procedure.
4. Manage the planning action of the x-ray table.
5. Operate auxiliary laboratory equipment, such as the Viamonte Injector and oximeter.

Duties as charge technician--As the charge technician, it is also the responsibility of the NCOIC to:

1. Maintain the work schedules and on-the-job-training of his technicians.
2. Order and maintain laboratory supplies.
3. Insure high standards of cleanliness in the laboratory.
4. Maintain the four quality control systems necessary for the safety of the patient: environmental, electrical, radiologic, and bacteriologic.

The Scrub Technician's Responsibilities

The job description of the scrub (cardiopulmonary lab) technician is stated in Form 9 (Appendix A). It is the responsibility of this technician to:

1. Set up the sterile table.
2. Prepare the transducers, solution line, and manifolds.
3. Drape the patient.
4. Help the cardiologists don their sterile gowns and gloves.
5. Directly assist the cardiologists during the procedure.

The Electronic Technician's Responsibilities

This technician's responsibilities as a member of the cath team are primarily directed to quality control, electronic and/or electrical safety, and specific duties during the procedure (27, 31, 68, 74, 75, 82, 83, 87). The electronic technician will:

1. Prepare the monitoring system.
   a. Be sure it is functioning properly.
   b. Load the recording paper.
   c. Balance and calibrate the transducer.

2. Apply ECG leads to insure a steady, reliable tracing, demonstrating proper lead placement (Figs. 2 and 3).

3. Monitor cardiac rhythm during the procedure, and notify cardiologist of changes. ECG changes to be recognized include:
   a. Changes in the QRS complex and heart rate
   b. Sinus bradycardia and sinus arrest
   c. Heart blocks
   d. Atrial and ventricular premature beats
   e. Atrial tachycardia, flutter, and fibrillation
   f. Ventricular tachycardia and fibrillation

4. Monitor pressures during the procedure, and call out catheter location by pressure indication. Pressure patterns to recognize, and their appropriate abbreviation to be called out, include:
   a. Aortic = "A-O"
   b. Left ventricular = "L-V"
   c. Vena cava = "V-C"
   d. Right atrial = "R-A"
   e. Right ventricular = "R-V"
   f. Pulmonary arterial = "P-A"
   g. Pulmonary wedge = "wedge"
   h. Damping = Should be called out <u>whenever</u> observed.
   i. Loss of pressure = "Off pressure." Should be called out <u>whenever</u> observed.

5. Call out PVCs (VPBs), by number. (For instance, if three sequential PVCs occur, call out "3." If PVCs begin to run, call out "running.")

6. Record the various phases of the procedure.

7. Supervise monthly electrical equipment checks and maintain records. (See Form 10, in Appendix A.)

8. Check and record calibration factors of the pressure transducers with a mercury manometer, and check monthly for malfunctioning.

The X-Ray Technician's Responsibilities

This team member must be knowledgeable in the operation of all the x-ray equipment and in the development of x-ray film. He must know how to obtain the best performance from the available equipment, closely monitor quality control, and initiate periodic maintenance and immediate adjustments when needed (5). His specific cath team responsibilities focus on quality control, radiation safety (96), and functions performed in the laboratory itself, which include:

1. Preprocedure equipment check
2. Measurement of patient's chest
3. Calibration of equipment, after the patient is secured in the Rotacor
4. Management of fluoroscopy, tape recorder, film magazine, and television monitor during procedures (35)
5. Rotation of the patient to positions desired by the cardiologist
6. Notifying the cardiologist of the amount of film remaining
7. Capability to play back films upon the cardiologist's request
8. Monitoring, recording, and reporting to the Cardiovascular Nurse the amount of fluoroscopy time expended

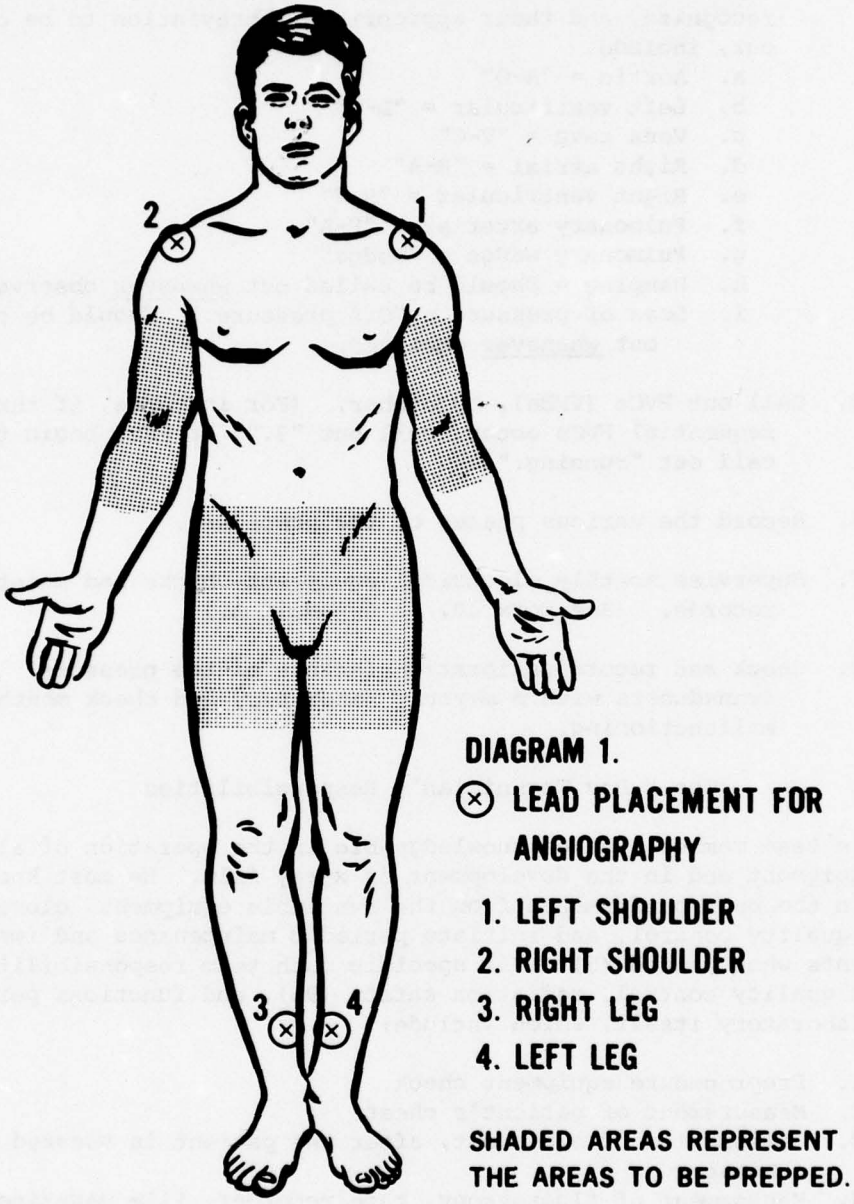
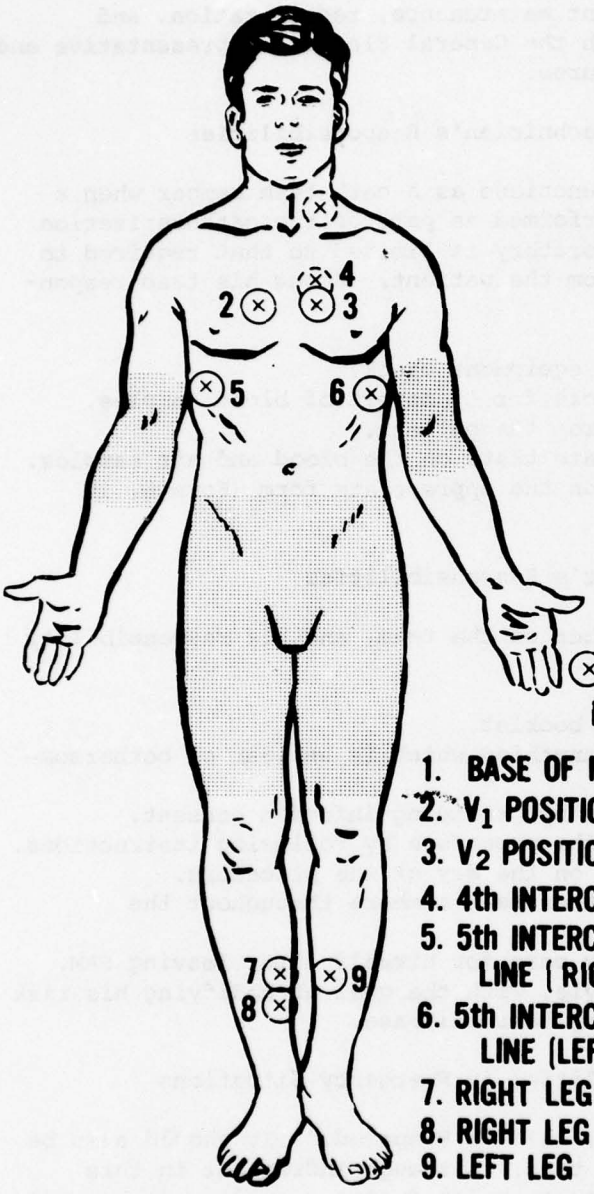


Figure 2. Proper lead placement for angiography.



⊗ LEAD PLACEMENT FOR ELECTRICAL STUDY

1. BASE OF NECK (REAR)
2. V_1 POSITION (4th INTERCOSTAL R. SIDE)
3. V_2 POSITION (4th INTERCOSTAL L. SIDE)
4. 4th INTERCOSTAL L. SIDE, REAR
5. 5th INTERCOSTAL SPACE MID AUXILIARY LINE (RIGHT SIDE)
6. 5th INTERCOSTAL SPACE MID AUXILIARY LINE (LEFT SIDE)
7. RIGHT LEG
8. RIGHT LEG
9. LEFT LEG

Figure 3. Proper lead placement for electrical study.

9. Immediately after the procedure, developing the film and preparing it for viewing
10. Coordinating equipment maintenance, recalibration, and routine checks with the General Electric representative and the NCOIC and/or nurse.

The Pulmonary Technician's Responsibilities

The pulmonary technician functions as a cath team member when a Fick output determination is performed as part of the catheterization procedure. His time in the laboratory is limited to that required to obtain the necessary samples from the patient. Among his team responsibilities are to:

1. Perform preprocedure equipment check.
2. Provide iced receptacle for transport of blood samples.
3. Collect air sample from the patient.
4. Perform the appropriate tests on the blood and air samples.
5. Record the findings on the appropriate form (Form 6, in Appendix A).

The Patient's Responsibilities

The patient is a vital member of the team, and his responsibility is to:

1. Read the orientation booklet.
2. Ask questions about anything which is unclear or bothersome to him.
3. Request the procedure by providing informed consent.
4. Prepare himself for the procedure by following instructions.
5. Report appropriately on the day of the procedure.
6. Cooperate with the other team members throughout the procedure.
7. Learn how to properly care for himself after leaving SAM.
8. Evaluate his life style, with the goal of modifying his risk factors for coronary heart disease.

The Team Responsibilities in Emergency Situations

The motto of Scouting, USA, is: "Be Prepared." It should also be the motto of the cardiovascular team. Although infrequent in this laboratory, emergency situations can arise during a cardiac catheterization procedure. Each team member should know his or her responsibilities, and be ready to carry them out calmly and efficiently (2, 6, 16, 33, 36, 39, 61, 86, 95).

Team responsibilities for three specific emergency situations are presented in the following order--air embolism, cardiac arrest, and ventricular fibrillation:

Air Embolism--

1. Cardiologist's duties:
    a. Direct the team.
    b. Remove catheters from patient, if indicated.
2. Nurse's duties:
    a. Administer oxygen via cannula or mask.
    b. Keep records.
3. NCOIC/Circulating Technician's duties:
    a. Call for stretcher and extra pillows from Nursing Unit.
    b. Notify hyperbaric chamber team of patient requirements.
    c. Assist with patient transfer from Rotacor to stretcher, and from cath lab to hyperbaric chamber.
4. Scrub Technician's duties:
    a. Assist cardiologist.
    b. Clear away sterile equipment.
    c. Assist with patient transfer.
5. Electronic Technician's duties:
    a. Monitor patient.
    b. Keep records.
6. X-ray Technician's duties:
    a. Raise tower.
    b. Turn lights on.
    c. Rotate patient to LAO (left anterior oblique), 45-50 degrees (arterial embolus); RAO (right anterior oblique), 45-50 degrees (venous embolus).

It is essential to: Get the patient into Trendelenburg position; administer oxygen; remove all catheters; and transfer patient to the hyperbaric chamber. Pillows placed under the feet and legs of the patient on the stretcher facilitate Trendelenburg positioning if the stretcher itself cannot be manipulated. At SAM, transfer from Building 110 (Cardiovascular Laboratory area) to Building 160 (Hyperbaric Medicine) is accomplished by stretcher, the patient being accompanied by the cardiologist and at least two technicians. Oxygen should be administered throughout the transfer.

Cardiac Arrest--

1. Cardiologist's duties:
    a. Direct the team.
    b. Initiate external cardiac massage.
    c. Initiate intubation.
2. Nurse's duties:
    a. Defibrillate when required.
    b. Administer medication.
    c. Monitor patient.
    d. Keep records.

3. NCOIC/Circulating Technician's duties:
    a. Place steps for cardiologist.
    b. Place blocks under Rotacor.
    c. Provide medications and emergency supplies.

4. Scrub Technician's duties:
    a. Remove x-ray tower from patient area.
    b. Manage airway.

5. Electronic Technician's duties:
    a. Monitor patient.
    b. See that monitoring equipment is not overloaded during defibrillation.
    c. Keep records.

6. X-ray Technician's duties:
    a. Raise x-ray tower.
    b. Turn lights on.
    c. Level and lock Rotacor.
    d. Upon the cardiologist's order, call the Base Clinic for transfer ambulance, and notify Wilford Hall USAF Medical Center of transfer.

Ventricular Fibrillation--

1. Cardiologist's duties:
    a. Direct the team.
    b. Administer medication.
    c. Initiate external cardiac massage if defibrillation is ineffective

2. Nurse's duties:
    a. Prepare for defibrillation, bare patient's chest.
    b. Defibrillate.
    c. Administer medication.
    d. Keep records.

3. NCOIC/Circulating Technician's duties: Assist as directed.

4. Scrub Technician's duties: Stand ready to assist as directed.

5. Electronic Technician's duties:
    a. Monitor patient.
    b. See that monitoring equipment is not overloaded during defibrillation.
    c. Keep records.

6. X-ray Technician's duties:
    a. Raise x-ray tower.
    b. Turn lights on.
    c. Level and lock Rotacor.

If cardioversion is not achieved by defibrillation, the procedure for cardiac arrest should be implemented.

Summary

Presented in this report section is an overview of the team concept in the cardiovascular laboratory and of the respective team member's responsibilities relative to cardiac catheterization. The team is usually composed of three professional members (two cardiologists and a cardiovascular nurse); four paraprofessional members (circulating, scrub, electronic, and x-ray technicians); and the patient. During a Fick output determination, a pulmonary technician is also part of the team.

Recommended team responsibilities have been outlined for three types of emergencies: air embolism, cardiac arrest, and ventricular fibrillation.

CARDIAC CATHETERIZATION: PREPARATION AND PROCEDURE

The routine for a typical cardiac catheterization procedure is described in this report section. (Specific team member responsibilities have already been explained in the preceding section.)

Preparation the Day Before the Procedure

Human Preparation--

1. Patient: The patient should have as much time as needed with his cardiologist to understand thoroughly why the cardiac catheterization has been recommended, what it entails, and the potential risks involved. He should then spend sufficient time with the cardiovascular nurse to discuss his questions, provide informed consent, and establish a trusting relationship (51). He should be oriented to the catheterization laboratory and to the nursing unit. He should demonstrate an understanding of his precatheterization routine. He should receive his shave prep by one of the nursing unit personnel, and have a blood sample drawn for routine studies at the clinical laboratory.
2. Cath team: The cath team members coordinate their preparation for the procedure. Each member needs to know what kind of procedure the cardiologist has planned. The nurse insures that all members know about the procedure. The team has a precatheterization meeting to discuss the procedure and to determine the number and types of catheters and equipment desired. The information is recorded on a work sheet. (Consult Form 16, in Appendix A.)
3. Nursing Unit personnel: The cardiovascular nurse will inform the NCOIC of the Nursing Unit about the procedure, the name of the patient, the time he is to report to the unit, and the areas to be prepped. The NCOIC will determine who will orient the patient to the unit, and who will perform the prep, and will arrange for proper coverage of the unit while the patient will be inhouse.
4. All involved persons: In order to function optimally, each person involved with the patient and the procedure should have a good night's sleep.

Environment Preparation--

1. Supplies and equipment: Adequate supplies should be kept available for use in the laboratory at all times; however, these will be checked for sterility and readiness. Necessary unsterile supply levels will be checked as well.

Mechanical and electrical equipment will be checked for proper functioning (12, 27, 62, 75, 82, 83, 89). A checklist is used for this purpose (Form 11, in Appendix A).

2. Ambient environment: Current reports of floor conductivity, bacteriologic, and radiologic monitoring will be checked. The floor of the lab will be wet vacuumed, using a germicidal solution, late the afternoon before the procedure.

Record Preparation--Cath team members and nursing unit personnel have record-maintenance functions. The nurse is responsible for initiating the patient's catheterization chart, obtaining his SAM record from the Flight Medicine Branch, and checking the record for completeness and discrepancies. Catheterization charts are assembled and kept in the cath lab office. Each chart contains the following forms:

1. One SAM Form 81, "Medical Orders"
2. One Standard Form 600, "Chronological Record of Medical Care"
3. One Standard Form 522, "Request for Administration of Anesthesia and for Performance of Operations and other Procedures" (Form No. 3, in Appendix A)
4. Three SAM Forms 96, "Nursing Record"
5. One SAM Form 265, "Subject's Deposit Certificate"
6. One form, "Cardiac Catheterization Record" (Form No. 6, in Appendix A)
7. One SAM Form 16, "Catheterization" (Form No. 5, in Appendix A)
8. One "Cardiovascular Laboratory Patient Flow Sheet" (Form No. 4, in Appendix A)
9. One Framingham "risk predictor" form (Form No. 7, in Appendix A)

Preparation on the Day of the Cardiac Catheterization Procedure

Human Preparation--The cath team, nursing unit personnel, and the patient should report on time, mentally and physically prepared for the procedure. The patient will be greeted by the nursing unit technician on duty, shown to his room, given fresh pajamas, have his vital signs taken and recorded, and have his valuables secured. The cath team will don surgical greens, conductive or washable shoes or shoe covers, hats, and masks, and report to the laboratory.

Environment Preparation--In the laboratory, all equipment and surfaces will be damp dusted with a germicidal solution. Electrical equipment, supplies, and drugs will be checked and prepared for use. Contrast media will be warmed to body temperature in the warming box. Sterile supplies and equipment, drugs and solutions, and the injector

will be prepared for use. The scrub technician's procedure for readying the sterile tables and equipment is given in Form 12. The circulating technician's tasks are enumerated in Form 13. The nurse supervises these preparations (Form 14); and Form 15 represents her checklist. (For Forms 12-15, refer to Appendix A.)

Procedure

The patient will be given an opportunity to empty his bladder, and then be escorted to the laboratory by a member of the cath team, usually the nurse. He will be assisted into proper position on the Rotacor. His blood pressure and pulse will be recorded, and pulses distal to the catheter insertion site(s) will be marked. Movement of the equipment should be demonstrated after the patient has been secured to the Rotacor. If a sedative has been ordered, the nurse will administer it. The electronic technician will place ECG electrodes on appropriate sites, after wiping the areas with an alcohol sponge and rubbing them with an abrasive, and will obtain a baseline heart rate and ECG. The x-ray technician will calibrate the x-ray equipment and record the patient's identification plate and a magnification grid. The nurse will initiate an intravenous infusion of 5% glucose per Angiocath in the patient's right or left forearm, if so indicated; she will instruct the patient regarding breath-holding (without performing the Valsalva maneuver) and diaphragmatic coughing. The circulating technician and/or the nurse will perform a 5-min Betadine prep of the patient's right and left inguinal areas and possibly his right and/or left antecubital fossae. The prep procedure is set forth in Form 17 (Appendix A). The scrub technician will position his sterile setup, drape the patient, and complete the connection and checking of his solution and pressure lines. The cardiologist will then perform the actual procedure.

Patient safety is crucial. This safety is accomplished by a concerted team effort. The electronic technician will closely monitor the ECG and pressure tracings. The nurse will monitor physiologic and psychologic responses of the patient to the procedure, and to the administration of medications and contrast medium. Once the cardiologist has sufficient data for diagnostic purposes, he will complete the procedure. Some individual patients will require electrophysiologic conduction studies which are usually performed the day after angiographic studies.

All cardiac catheterization studies require close observation, but the patient is more vulnerable to complications during catheter manipulation and coronary angiography. Especially vulnerable are individuals with bundle branch blocks and/or significant coronary artery disease. Therefore, the nurse's primary concerns are anticipation and recognition of complications--and, if necessary, appropriate rapid action during those particularly vulnerable times (9, 72).

Immediate Postprocedure Care

After the last arterial catheter has been removed, the cardiologist will provide manual pressure at the puncture site for at least 10 min to facilitate arterial closure if a percutaneous approach is used. If a brachial arteriotomy is performed, sutures will be used to close the artery and skin. Once hemostasis has been established, the patient will be prepared for transfer to the nursing unit. The drapes will be removed, operative area cleaned, an antibiotic cream applied to the puncture or cutdown site, and a small dressing applied. The leg electrodes will be removed, the shoulder electrodes disconnected, and the patient's pulse and blood pressure recorded. Nursing unit personnel will bring a stretcher to the laboratory, and the patient will be carefully lifted from the Rotacor. After being secured on the stretcher, the patient will be transported to his room on the nursing unit, and transferred to his bed.

Routine Postcatheterization Care (91)

Immediate Care on Unit--

1. As soon as the patient is in his bed in the nursing unit, electrodes are attached for continuous cardiac monitoring, using the MCL_1 lead (47, 73). The character of his right pedal and/or radial pulse is assessed by comparing it simultaneously with the corresponding pulse on the left side, and evaluating perfusion of that extremity. The dressing is checked, and instructions are given about keeping the affected leg straight and/or about arm usage. The blood pressure and temperature are checked, and instructions are given about bedrest. A standard 12-lead ECG is performed approximately one hour after arrival back on unit.

2. If the percutaneous femoral approach was used, the patient is kept at bedrest for 16 to 20 hr, for the first 2 hr of which he must remain flat with a sandbag over the femoral artery puncture site, unless the cardiologist specifies differently. After a Sones procedure, the patient is instructed not to: hyperextend his right arm, flex it more than 30°, place it under his head, or lie on it. Patients who have only had a brachial arteriotomy are permitted ambulation, as desired, after 4 to 6 hr have elapsed and it is certain that the clinical status is stable. At the time

the patient first leaves his bed, he is accompanied and assisted by a medical technician who is also present at the bedside for the first urination postcatheterization. The vital signs, pulse, perfusion assessments, and handgrip check are accomplished on a routine basis.

3. Fluids are offered and encouraged every hour, for the first 6 to 8 hr, to compensate for the dehydrating effect of the contrast medium used during the procedure. Accurate intake and output are recorded to apprise the staff of the patient's general fluid balance and kidney function.

4. The I.V. is maintained to keep the vein open until the cardiologist determines the results of the catheterization, and the patient is stable.

5. Since the patients at the School of Aerospace Medicine who undergo the procedure are neither chronically nor acutely ill, an uneventful recovery is expected (30, 94). However, the nurse and the nursing unit personnel must be able to detect any potential problem and take appropriate action (2, 11, 40, 41, 60, 71, 86, 90).

First, by evaluating the findings, both objectively and subjectively, the seriousness of any situation must be assessed. This assessment is accomplished via several universal guidelines which are subdivided into: those completed prior to notifying the physician, and those accomplished while waiting for the physician after he has been notified.

In addition, the clinical finding is assessed as to the most probable area involved; i.e., heart, cutdown or percutaneous site, remedication and/or local anesthetic, or the patient's emotional state (4, 14, 34).

Universal Guidelines--Following are the universal guidelines (or steps) which should, if possible, be completed and recorded before notifying the physician:

1. Objective evaluation of findings:

   a. Location

   b. Type

   c. Onset

   d. Vital signs: blood pressure, pulse rate (taken for 1 full minute)

   e. Radial and/or pedal pulse strength by comparison with the opposite side pulse

   f. ECG rhythm strip and/or a full 12-lead ECG

   g. Color and temperature of the extremity used for the procedure

   h. Quality of heart sounds

2. Subjective evaluation of findings: Patient's statements as to the details of his problem.

The completion of these universal steps is essential in the nurse's and/or technician's decision regarding physician notification--a decision based on whether or not the findings require immediate action, immediate notification, or a watch-and-wait situation.

If the nurse's decision is for immediate action, she accomplishes it and simultaneously has a physician notified. For example, if ventricular fibrillation were to occur, it would require immediate direct current countershock and the establishment of an intravenous line before anything else were accomplished. Because this type of complication has never arisen at USAFSAM, and is extremely rare in most settings after cardiac catheterization procedures, only those steps necessary in the immediate notification and watch-and-wait situations are detailed here.

Immediate Notification--A fully trained medical technician stays on the unit with the patient at all times. If the patient has serious disease diagnosed by arteriography, or other problems for problems, the nurse and/or physician will stay on the unit after hours until the patient is transferred to a hospital facility or discharged.

If the technician on duty alone is not sure whether to call a professional team member, but knows the situation is not one requiring immediate action, he calls the NCOIC of the nursing unit who decides if further notification is warranted. If a watch-and-wait situation occurs, the technician notifies the nurse and the unit NCOIC. For immediate notification, the physician is called first, then the nurse and the unit NCOIC. If there is no time to make multiple calls, one call to the base Command Post is sufficient to insure that physician, nurse, and NCOIC will be immediately notified.

After the nurse or technician has determined that the finding requires immediate notification of the physician, the following universal guidelines should be carried out while awaiting the physician's arrival:

1. A current 12-lead ECG

2. If the patient does not already have one, an I.V. of 5% dextrose in water (D/W), with a large needle or angiocath, is started.

Specific steps are determined by the presenting clinical finding. They supplement the universal guidelines, and are listed under the finding to which they relate. A specific list of possible complications is needed to assist the nurse or technician in determining the priority of the presenting clinical findings. Immediate notification is accomplished at the completion of the universal steps. Watch-and-wait action requires close observation and evaluation of the patient, continuously every 5 to 15 min. If, during the observation period, the finding increases in severity or persists, the technician must notify the physician.

The following guidelines should aid the nurse and/or technician in their clinical decision:

1. What is the most probable area of cause?

2. What is the priority of intervention?

One must remember that these guidelines are only for reference, and do not include all possible situations (25, 29, 39, 42, 45, 46, 69, 79).

Arrhythmias and/or Systemic Circulatory Findings--Those findings, related to the heart and/or cardiovascular system, which require immediate notification of a physician are (Table 1):

1. Sinus tachycardia, with a heart rate of greater than 120 bpm.
2. Bradycardia, with a heart rate of less than 45 to 50 bpm, unless the subject's usual heart rate is slower.
3. Irregular cardiac rhythm, not present before the procedure, or more prominent after it.
4. Mental confusion. This finding could be secondary to an arrhythmia or thrombotic process.
5. Blurred vision. In addition to the possibility of an arrhythmia or thrombotic process, this finding could be a reaction to medication or to the radiopaque material used during the procedure.

Findings Indicative of Infarction, Embolism, and/or Shock--The next group of immediate notification findings relating to the heart and/or cardiovascular system require the universal steps, plus the indicated specific steps:

1. Chest pain
2. Shortness of breath
3. Cyanosis
4. Hypotension, with a systolic blood pressure of approximately less than 90 mmHg.

The first three findings require elevation of the bed, in a semi-Fowler's position (providing shock is not present), and administration of oxygen. Every attempt should be made to accomplish the universal steps of obtaining a 12-lead ECG, and starting an I.V. while awaiting the physician. The finding of hypotension requires the additional steps of keeping the patient warm and the bed flat or in the Trendelenburg position (6, 33, 61, 80, 84, 88).

Findings Related to Hypersensitivity to Injected Substances--The next two immediate notification findings relate to either the medications, including premedication, or the radiopaque contrast medium (an iodinated base compound):

1. Urticaria
2. Temperature elevation of greater than 100° F.

These findings, by themselves, do not usually require taking the 12-lead ECG; but they do require that the other universal steps be completed before the physician is called, and that an I.V. be started while awaiting his arrival.

TABLE 1. CLASSIFICATION OF CLINICAL PROBLEMS POSTCARDIAC CATHETERIZATION WHICH REQUIRE IMMEDIATE NOTIFICATION OF THE PHYSICIAN

Clinical finding	Possible cause	Nursing activities
1. Tachycardia (Heart rate: 120 bpm)	Cardiovascular Supraventricular tachycardia Ventricular tachycardia Fluid imbalance (dehydration) Associated with elevated temperature Medication (i.e., atropine) Anxiety Bleeding (hemorrhage)	Subjective evaluation Objective evaluation Vital signs--comparison with precath values *ECG rhythm strip--as soon as possible I.V. 5% D/W via indwelling venous catheter
2. Bradycardia (Heart rate: 45-50 bpm)	Cardiovascular Myocardial infarction Hypotension Vasovagal	Subjective evaluation Objective evaluation Cyanosis Vital signs--comparison with values *ECG rhythm strip--as soon as possible I.V. 5% D/W via indwelling venous catheter
3. Chest pain (Sudden onset)	Cardiovascular Myocardial infarction Pulmonary embolus Perforated intra-thoracic vessel Perforated myocardium	Subjective evaluation Objective evaluation Vital signs--comparison with precath values SPECIFIC localization and description of pain Oxygen 4 - 6 liters/min via nasal cannula or mask *ECG rhythm strip--as soon as possible I.V. 5% via indwelling venous catheter
4. Shortness of breath	Cardiovascular Arrhythmia Congestive heart failure Myocardial infarction Cerebral embolus Pulmonary embolus Respiratory Chronic obstructive lung disease Allergic reaction to medication or contrast media	Subjective evaluation Objective evaluation Vital signs--comparison with precath values Evaluate accompanying signs (i.e., PAIN--type, location) CYANOSIS *ECG rhythm strip--as soon as possible Oxygen 4 - 6 liters/min via nasal cannula or mask; this treatment is pertinent only if the patient does not have chronic lung disease I.V. 5% D/W via indwelling venous catheter *12-lead ECG is essential in differential diagnosis, and should be accomplished at earliest possible time

* 12-lead ECG should be obtained at the first possible opportunity, but not until immediate steps have been accomplished.

(Cont'd. on facing page)

TABLE 1 (Cont'd.)

Clinical finding	Possible cause	Nursing activities
5. Cyanosis	Cardiovascular Anemia (severe) Arrhythmia Congestive heart disease with associated polycythemia Respiratory Chronic obstructive lung disease (with associated polycythemia)	Subjective evaluation Objective evaluation Vital signs--comparison with precath values Evaluation of accompanying signs (i.e., PAIN--type, location, shortness of breath) *ECG rhythm strip--as soon as possible Oxygen 4 - 6 liters/min via nasal cannula or mask I.V. 5% D/W via indwelling venous catheter
6. Hypotension (Systolic 90 mmHg)	Cardiovascular Arrhythmia Blood loss Central nervous system Fluid imbalance (dehydration) Reaction to medication Vasodilators--Nitrates	Subjective evaluation Objective evaluation Vital signs--comparison with precath values *ECG rhythm strip--as soon as possible I.V. 5% D/W via indwelling venous catheter Keep patient warm
7. Neurologic deficit	Cardiovascular Arrhythmia Bradycardia Supraventricular tachycardia Cerebral or pulmonary embolus Reaction to medication used Atropine Sedatives, etc. Reaction to contrast media	Subjective evaluation Objective evaluation Vital signs--comparison with precath values Evaluation of any accompanying signs; i.e., headache, neurologic deficit (specific level of consciousness) Visual impairment *ECG rhythm strip--as soon as possible I.V. 5% D/W via indwelling venous catheter
8. Blurred vision	Cardiovascular Arrhythmia Cerebral embolus Reaction to medication used Reaction to contrast media	Subjective evaluation Objective evaluation Vital signs--comparison with precath values Evaluation of any accompanying signs; i.e., scotoma headache pain (orbital) bilateral vs. unilateral neurologic deficit (SPECIFIC level of consciousness) I.V. 5% D/W via indwelling venous catheter

* 12-lead ECG should be obtained at the first possible opportunity, but not until immediate steps have been accomplished.

The specific steps required for the finding of urticaria include close monitoring for any respiratory complication, and preparation of an antihistamine and/or steroid preparation for injection. The physician may request that the nurse or technician accomplish these steps while waiting for him to arrive.

A temperature elevation could represent either a pyogenic response to materials used during the procedure, or possible contamination of the local percutaneous or cutdown area, or a bacterial contamination of the patient's circulatory system (septicemia). Here, blood cultures would be required to aid the diagnosis.

Findings Specific to the Area(s) of Catheter Insertion--The remaining two immediate notification findings are:

1. Hemorrhage
2. Loss of peripheral pulse

These findings usually relate to the brachial artery cutdown or femoral percutaneous site. If hemorrhage occurs in either area, local pressure is applied to the involved area; and all the universal steps except an ECG, unless specifically indicated by other findings, are performed (40, 41).

If a peripheral pulse is lost, the physician is immediately notified and the patient is made as comfortable as possible. If the patient is asymptomatic, it is imperative that the technician or nurse does not create any undue mental stress for him by "pushing the panic button." One simply alerts the physician to come in, examine the patient, and evaluate the situation.

Watch-and-Wait Situations in General--Six clinical findings compromise the watch-and-wait type of situation (Table 2). Here, again, let us emphasize that the universal steps are completed for each of these findings, with specific steps as applicable. Also, it is most important to observe the patient closely--checking him and reevaluating the clinical findings as often as necessary for the problem, but certainly not less than every 5-15 min. If the finding persists, or becomes more acute, the physician should be notified immediately.

Specifics for Watch-and-Wait Situations--

1. The first two of these watch-and-wait findings are related to the cutdown (brachial) or percutaneous needle puncture (femoral) site:
   a. Diminished pulse
   b. Hand and/or foot is:
      (1) cold
      (2) cramping
      (3) weak
      (4) painful
      (5) cyanotic

TABLE 2. CLASSIFICATION OF CLINICAL PROBLEMS POSTCARDIAC CATHETERIZATION WHICH REQUIRE WATCH-AND-WAIT OBSERVATION BY NURSE*

Clinical finding	Possible cause	Nursing activities
1. Diminished pulse	Procedure Dressing	Comparison of both right and left radial/pedal pulses Dressing check: (a) too tight (b) Allen test for radial artery integrity: Does palm become "pink" when ulnar artery compressed? Hand grasp: Is it firm? Capillary refill check: Do nailbeds promptly "pink" up?
2. Hand/Foot: cold cramping	Procedure Dressing Arm/hand or foot/leg positioning: Rigid lying on-- arm and/or leg arm under head	Comparison of both right and left radial/pedal or posterior tibial pulses Dressing check: (a) too tight (b) Allen test for radial artery integrity: Does palm become "pink" when ulnar artery compressed? Hand grasp: Is it firm? Capillary refill check: Do nailbeds promptly "pink" up? Warmth: Locally--may have patient place hand on abdomen
3. Sinus bradycardia (but rates at least 45-50 bpm)	Medications preprocedure sedation Nitrates--during cath Emotional and/or syncopal responses	Universal steps Comparison with preprocedure values ECG
4. Sinus tachycardia (but rate less than 120 bpm)	Medications pre/during procedure (i.e., Atropine--for bradycardia) Anxiety Dehydration	Reassurance Universal steps Comparison with preprocedure values ECG Encourage fluids Reassurance
5. Systolic hypotension (but not less than 90 mmHg)	Medications preprocedure sedation Nitrates--during cath Emotional and/or syncopal responses Dehydration	Universal steps Comparison with preprocedure values ECG rhythm strip Encourage fluids Reassurance
6. Diplopia or scotoma	Contrast media	Universal steps Delineation: Unilateral vs. bilateral Transitory vs. fixed Scotoma vs. no scotoma

* This classification requires an evaluative decision statement, reassurance, and close observation, with 5 - 15 min monitoring of vital signs and evaluation of findings. If findings persist, an "immediate notification" situation exists; also, a "no" response to any question shows an "immediate notification" situation.

The pulse of the artery used for the procedure is checked, comparing its fullness with the corresponding pulse on the opposite side, and noting how full it was before the procedure.

2. The specific steps needed for complete evaluation are:

    a. Check the dressing. (Is it too tight?)
    b. Check circulatory integrity by:
        (1) Assessing capillary filling to the nailbeds.
        (2) Allen's sign--that is, separately checking the integrity of the radial and ulnar arteries with alternate compression and observing hand perfusion. (Does the hand "pink-up" normally?)
        (3) Checking handgrip. (Is it firm?)

A "No" answer to any of the foregoing questions calls for immediate notification of the physician. A diminished pulse or discomfort in the hand frequently occurs because the patient did one of three things--held his arm or hand rigid; flexed his elbow greater than 30°; or lay on his right arm under his head for an extended period. The majority of such problems can be prevented by giving specific instructions about the use, and limitations of use, of the arm and leg, and explaining the possible detrimental consequences.

If the arm was used, the patient is encouraged to move his arm and use his hand, but is advised to avoid hyperextension or flexion of greater than 30°. If the abnormal findings persist, another helpful treatment is to have the patient place his hand under his shirt on his abdomen, or apply a warm compress to the operative site.

3. Four findings, related to the cardiovascular system, are:

    a. Sinus bradycardia, but with a heart rate of at least 45 to 50 bpm, unless the patient's usual heart rate is slower.
    b. Sinus tachycardia, but with a heart rate of less than 120 bpm or any tachyarrhythmia or heart irregularity.
    c. Systolic hypotension with a systolic blood pressure of at least 90 mmHg, depending on the patient's precatheterization blood pressure.

It should be remembered that the use of nitrates in the catheterization laboratory can cause a transitory fall in the blood pressure. By encouraging fluids (a minimum of 8 oz. per hr orally for 6-8 hr), the problem of hypotension can usually be alleviated.

d. Diplopia or scotomata. This finding can be related to the contrast medium or cardiovascular system. It is important to obtain a complete ECG and a rhythm strip to detect any cardiac arrhythmias or damage which could be a cause of this finding (91).

Procedures this Laboratory is Equipped to Perform

This laboratory has the capability of performing the following procedures:

1. Insertion of temporary cardiac pacemaker (36, 90)
2. Right heart catheterization, percutaneous or cutdown approach (36, 66)
3. Left heart catheterization, Judkins or Sones (15, 35, 36, 50, 79, 93)
4. His bundle electrocardiography (38)
5. Atrial pacing (48, 90)
6. Electrical studies (48)
7. Cardiac output studies, Fick or Cardiogreen methods (36, 49)
8. Cineangiography: atrial, pulmonary, ventricular, aortic, or coronary (21, 22, 28, 36, 85, 97)
9. Pressure measurements: aortic, ventricular, atrial, vena caval, pulmonic, pulmonary wedge (36, 84, 90)
10. Cardioversion (90: pp. 197-214)
11. Basic and advanced life support (16, 95)

Summary

Sequential activities before, during, and after a cardiac catheterization procedure have been presented in this report section. Everything relates directly to the safety, comfort, and well-being of the patient. Since the procedure is diagnostic in nature, no unnecessary risks are justified. The patient must be optimally prepared--both psychologically and physically--for the catheterization, protected from harm, and provided with expert care throughout the experience.

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Grateful appreciation is given to Lt. Col. Mary M. Thomas, USAF, NC (Ret) [Internal Medicine Branch, Clinical Sciences Division, USAFSAM], for material, in this report section, pertaining to the care of the patient following a cardiac catheterization procedure.

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ASEPTIC TECHNIQUE AND ENVIRONMENTAL CONTROLS

Introduction

What is aseptic technique? Sepsis is the presence of pathogenic microorganisms or their toxins in body tissues. Asepsis is the absence of such substances in body tissues. Therefore, aseptic technique is the name given those procedures or measures taken to prevent the introduction of pathogenic microorganisms or their toxins into body tissues. It is behavior directed toward preventing infection.

Microorganisms have a natural environment. E. coli, for instance, are normally found and have an important function in the bowel. Staph. epidermis is normally found on the skin. In fact, 40%-60% of people normally harbor staphylococci in their respiratory tracts. These microorganisms and many others become pathogenic, or cause infection, when they are displaced to a new environment. The occurrence of an infection can be operationalized in four steps as shown in the "Infection Cycle" (Fig. 4):

Step 1. A reservoir of living potentially pathogenic microorganisms is present (i.e., an existing infection, bowel, respiratory tract, skin, etc.).

Step 2. A way of exit exists, allowing the microorganisms to leave their reservoir (pus, defecation, coughing, desquamation, etc.).

Step 3. A vector or agent exists which facilitates the transfer of the microorganisms from the reservoir to a new location or host (i.e., air currents, dust, skin, etc.).

Step 4. A way of entry into the new host exists for the displaced microorganisms where they are pathogenic and cause a tissue response or infection (i.e., break in skin integrity) (52: pp. 29-30).

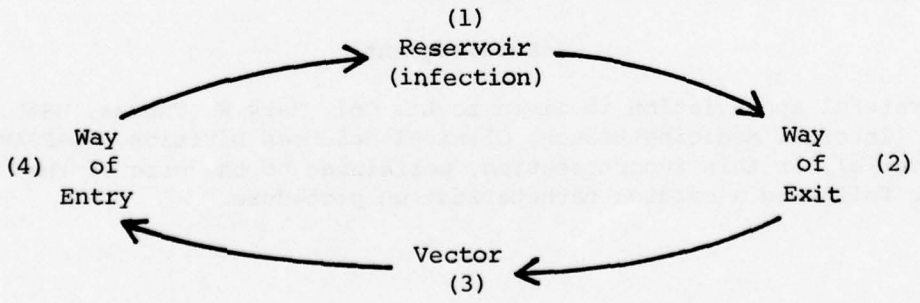

Figure 4. Infection cycle.

Aseptic technique, which involves interrupting the infection cycle, must be directed at blocking each step in the cycle:

Step 1. Reservoir of infection. To block infection at the reservoir level, sources of infection must be recognized and action taken. Health team members must be in good health themselves. A person with gastroenteritis, "flu," sore throat, poison ivy, or any similar problem must not work in areas where invasive procedures are performed.

Step 2. Way of exit. Blocking the exit of potential pathogens from their reservoirs includes the proper wearing of scrub clothing and filter masks.

Step 3. Vectors. Vectors take many forms and must be blocked accordingly. Means of blocking vectors include: stringent environmental controls; disinfection and sterilization procedures (76, 77, 98); use of protective clothing, such as caps, scrub clothing, masks, and shoes worn only in the procedure area; careful personal hygiene (78); surgical hand washing (52); and use of sterile gowns and gloves.

Step 4. Way of entry. An invasive procedure creates a potential way of entry for infection. Blocking pathogens at this step of the cycle involves preparing the patient's skin by preliminary hair removal; degerming, or surgical scrub, procedures; and sterile draping techniques (24, 43, 54, 55, 57).

This report section presents specific measures employed in the cardiovascular laboratory for the protection of the patient and the catheterization team members from infection.

Environmental Controls

Apparel (57, 67)--Proper attire during a cardiac catheterization includes: a scrub suit or scrub dress; conductive shoes or shoe covers; a cap which covers the hair; a mask which covers the mouth and nose; and a lead apron, when fluoroscopy and x-ray are in use.

1. Scrub clothing. Freshly laundered scrub clothing is provided for wear in the cardiovascular laboratory only. When worn outside the lab, this clothing must be covered by a clean lab coat. Scrub clothing is worn to protect the patient from pathogenic organisms which can be carried from the outside on the clothing of the team.

2. Conductive shoes. These shoes should be kept clean and the soles free of debris. Although no anesthetic gases are used or kept in the cardiovascular laboratory, conductive shoes are recommended, when conductive flooring is used,

because of the sophisticated electronic equipment which is employed. If conductive shoes are unnecessary or not available, shoes which are washable and worn only in the lab should be worn to prevent the tracking in of pathogens or dirt from the outdoors. Shoes should be washed frequently to eliminate blood and other debris which serve as ideal growing media for pathogenic microorganisms. Use of disposable conductive shoe covers protects the shoes from excessive soiling during a procedure.

3. Cap. The cap may be either disposable fabric or washable cotton and should be worn to cover the hair. This practice seeks to control the possible contamination of the sterile field from falling hair.

4. Mask. The mask should be disposable and worn to protect the sterile field and the patient from contamination by airborne pathogenic microorganisms which may be harbored in the upper respiratory tracts of the cardiovascular team. The mask should be discarded after leaving the lab. It should not be worn hanging around the neck or on top of the head. The mask should be changed between each case and as needed to insure proper filtering effectiveness.

5. Lead apron. The apron is to be worn by all team members who are not otherwise shielded whenever fluoroscopy or x-ray are used.

Ambient Environment--The temperature and humidity should be maintained at a constant level in the laboratory at all times for optimum equipment efficiency and comfort of the patient and the cardiovascular team (54, 55, 75, 82, 83).

Smoking is not permitted in the laboratory at any time.

Because the laboratory is open for promotional and educational tours, careful attention must be given to its preparation for a procedure. The floor should be thoroughly cleaned with a germicidal solution at least once a week; and mopped, using the same type of solution, immediately before and between procedures. All equipment and surfaces should be wiped down with a germicidal solution before and after a catheterization. The air vents should be cleaned every other week. The walls should be cleaned every month and as needed following procedures (54, 55).

Bacteriologic Controls--Bacteriologic cultures are done using spore strips (Spordi), with cultures being done in the steam and ethylene oxide gas sterilizers (13, 17, 37, 56, 60, 76, 77, 81, 98).

1. Bacterial spores are run biweekly on the steam autoclaves in a linen pack at a temperature of 120° C., for 30 min.

2. Gas sterilizer cultures are run monthly using the same sterilizing procedures as for sterilizing supplies.

3. After sterilization procedures are completed, spore strips are placed in a properly marked envelope and taken to the clinical laboratory for culturing.

4. Culture results are posted in a log book kept in the Central Sterile Supply Section.

5. Positive culture growth is a serious problem which must be handled immediately:
   a. Report the finding to the nurse and director of the laboratory at once.
   b. All items processed with the positively cultured test load, and those subsequent thereto, must be recalled and reprocessed through a safe sterilizer.
   c. If such items have been used for procedures before the culture report was received, the cardiologists involved must be notified regarding possible contamination. They may want to initiate prophylactic antibiotic therapy for their patients.
   d. Shut down the offending sterilizer to routine processing until a test load produces negative culture growth. For a laboratory with limited sterilization facilities, this could require closing the laboratory temporarily.
   e. Check the sterilizer for proper functioning and examine the loading procedure being used.
   f. If everything seems in order but a test load still cultures out positively, seek the help of medical maintenance or the manufacturer's local representative.

6. Quarterly spot cultures of laboratory furnishings and equipment are performed by clinical laboratory personnel using moist swab techniques.

7. Reports of bacteriologic findings are maintained by the NCOIC of the cardiovascular laboratory.

8. If positive culture growths are found, the following steps must be taken:
   a. Report the finding to the nurse.
   b. Thoroughly clean the equipment and/or furniture which yielded positive growth with a germicidal solution.
   c. Reculture.
   d. If a positive culture is again obtained, repeat the process. It may be necessary to use a different germicidal solution and/or improve cleaning procedures.

Aseptic Technique

An overview of the infection cycle and aseptic technique has already been presented in the "Introduction" to this report section (43, 52, 65).

Infection Cycle--By way of review, the four steps in the infection cycle are:

1. A reservoir of potential infection is present.
2. A way of exit for the pathogenic microorganisms exists.
3. A vector or agent exists to facilitate the transfer of the organisms.
4. A way of entry into the new host exists for the pathogens.

Rules--Four simple rules apply to the practice of aseptic technique during a procedure. Follow these rules, and aseptic technique can be assured:

1. Know what is sterile (germ free).
2. Know what is not sterile.
3. Keep the two apart.
4. Remedy contamination immediately (52).

These rules should be memorized and practiced until their use is automatic during every invasive procedure.

Application of Aseptic Technique Principles--During a cardiac catheterization, the four steps of the infection cycle and the four rules of aseptic technique must be kept in mind. The following guidelines are applications of the rules designed primarily at blocking vectors (65). *(NOTE: In these guidelines, a "sterile" person is one who has performed a surgical scrub and donned sterile gown and gloves.)*

1. All articles used in a study have already been sterilized.
2. Persons who are sterile touch only sterile articles; persons who are not sterile touch only unsterile articles.
   a. All supplies for the sterile team members reach them by means of a circulating staff member, through the medium of sterile forceps or sterile package wrappers.
3. If in doubt about the sterility of anything, consider it NOT sterile. For example:
   a. A sterile-appearing package found in a nonsterile workroom.
   b. An unsterile person brushes close to a sterile table.
   c. A sterile person brushes near an unsterile area.
   d. A sterile table or sterile articles are left unguarded and uncovered.
4. Unsterile persons avoid reaching over a sterile field. Sterile persons avoid leaning over an unsterile area. For example:
   a. The sterile person sets basins or glasses to be filled at the edge of the sterile table. The person circulating stands near this edge of the sterile table, but does not reach over it, to fill the basins and/or glasses.

b. The physician turns away from the sterile field to have perspiration wiped from his brow.
c. The sterile team member drapes an unsterile table toward him first.
d. The unsterile team member drapes a table away from him first.

5. Tables are considered to be sterile only at table level.
   a. Linen and sutures which fall over the table edge are discarded without the sterile person touching the part which hangs below table level.
   b. When uncovering a sterile table, be careful that the bottom edge of the sheet is not drawn up to table level where it would contaminate the sterile contents.

6. Gowns are considered sterile only from waist to shoulder in front and the sleeves, even if they are wrap-around in design.
   a. Sterile persons keep hands in sight at or above waist level.
   b. Hands are kept away from the face; elbows, close to the sides.
   c. Arms are never folded; there may be perspiration in the axillary area.
   d. Articles dropped below waist level are discarded; i.e., when picking up a gown, if the top of the gown drops below waist level, it must be discarded.

7. The edge of anything that encloses sterile contents is not considered sterile. For example, the edges of the wrappers on sterile packages, and the caps on solution flasks. No definite line separates the sterile from the unsterile at the wrapper's edge; therefore, the edge is considered unsterile.

8. Sterile persons keep within the sterile area. They should not wander about the room.

9. Unsterile persons keep away from sterile areas.

10. Sterile persons keep contact with sterile areas to a minimum.
    a. Do not lean on sterile tables or on the draped patient.
    b. Keep tables far enough away so that their gowns do not brush the tables.

11. Moisture facilitates contamination. When moisture soaks through a sterile area to an unsterile area, or vice versa, it provides a means of transporting pathogenic organisms to the sterile area.

12. Skin cannot be sterilized. The skin of the patient is a source of potential contamination in every procedure. However, this fact does not obviate the necessity for strict aseptic technique.

13. The air is potentially contaminated by dust and droplets.
    a. Masks are worn over the nose and mouth.
    b. Unnecessary talking is avoided.
    c. Sneezing and coughing are avoided.
    d. Persons with a cold or any acute infection are excluded from the laboratory.
    e. Corridors are considered contaminated areas.
    f. Sterile trays without covers are not transported through corridors.
    g. All dusting is damp dusting, accomplished with a germicidal solution.
    h. Soiled linen is placed in laundry bags promptly.
14. If a break in technique is reported, always perform as if the break actually occurred, even if you disagree at the time.

Surgical Scrub--The scrub procedure is done to remove as much of the epidermal bacteria and detritus as possible. This aim is accomplished by softening the detritus with soap and water before removing it with the friction action of scrubbing with a brush. Scrubbing the hands to a point of exciting dermatitis is a mistake. Light friction is effective and helpful in conditioning the skin.

Complete scrubbing by the clock usually takes 10 min. The anatomical brush-stroke method is generally 30 strokes to the fingernails and 20 strokes to each skin area (half-count to each of two brushes). Each step in the complete scrub procedure is listed in sequence in the following information (1: a-f).

In the cardiovascular laboratory, shorter scrubs are permitted after the initial scrub of the day and between cases. A short scrub takes 3 min, and is done to remove bacteria that have emerged from the pores and multiplied while the gloves were worn (52). Steps in the short scrub procedure are likewise listed in sequence in the following information (2: a-f).

1. Procedure for the complete scrub (Fig. 5):
    a. Adjust water flow to a comfortable temperature (Fig. 5: A and B).
    b. Wet hands and arms; dispense antiseptic agent and make a lather.
    c. Wash hands and arms to a level 2-3 in. above the elbows to remove gross dirt.
    d. Clean subungual spaces with a file or orangewood stick. Work lather between fingertips and nails (Fig. 5: C).
    e. Rinse fingers, hands, and arms thoroughly under running water. Hold hands above level of the elbows and away from the body, so that contaminated drippings can roll off at the elbows. Take precautionary measures to avoid splashing water on the scrub clothing.

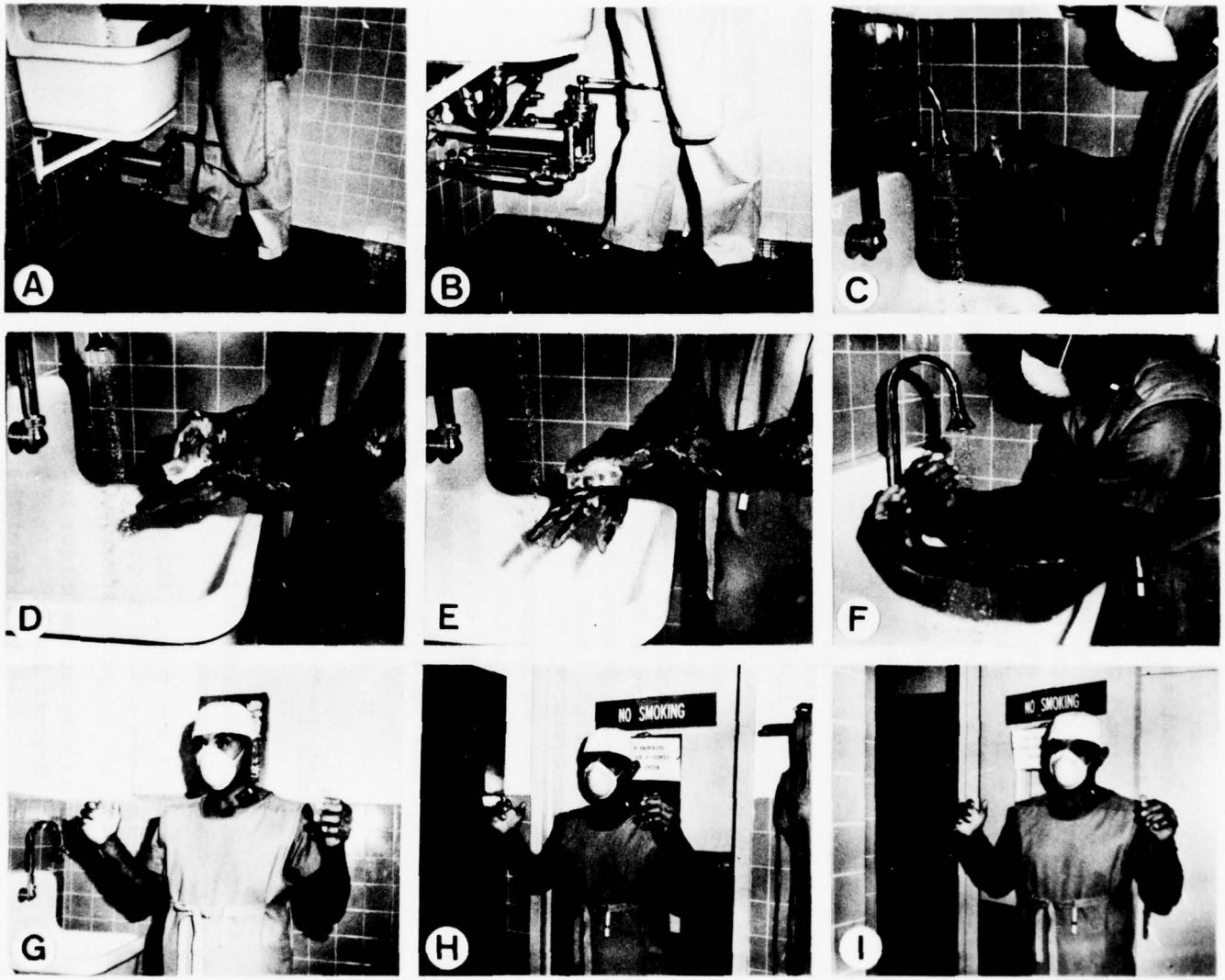

Figure 5. Scrub procedure.

f. Moisten brush with water and antiseptic agent. Hold brush perpendicular to fingertips and begin stroke count. Scrub all sides of digits, including web spaces. Maintain lather and scrub palm and back of hand (Fig. 5: D and E).
g. Repeat step "f" on second hand.
h. Maintain lather and scrub each arm on all sides to a level 2-3 in. above elbows. Hold hands above level of the elbows and away from the body so contaminants can drain off at the elbows.
i. Discard the brush. Rinse fingers, hands, and arms thoroughly under running water keeping hands above the elbows and away from the body. Avoid splash-back (Fig. 5: F and G).
j. With a new brush repeat the scrub procedure on hands and arms.
k. Discard brush and rinse thoroughly under rapidly running water.
l. Hold hands up and away from the body and proceed to the laboratory for drying (Fig. 5: H and I).

2. Procedure for the short scrub (Fig 5):
   a. Adjust water flow to comfortable temperature (Fig. 5: A and B).
   b. Wash hands and arms to a level 2-3 in. above elbows to remove detritus.
   c. Clean subungual spaces with file or orangewood stick. Work lather between nails and fingertips (Fig. 5: C).
   d. Use one brush to scrub fingers, hands, and arms. Maintain lather. Hold hands and arms above level of elbows and away from body (Fig. 5: D and E).
   e. Rinse well under rapidly running water (Fig. 5: F).
   f. Hold hands up and away from the body and proceed to the laboratory for drying (52: pp. 36-37) (Fig. 5: G, H, and I).

Gowning and Gloving--The steps in these procedures are shown in Figure 6.

1. Gowning. Immediately following the scrub, the sterile gown is put on.
2. Purpose of the gown. The sterile gown is worn in order to permit the wearer to come within the sterile field and carry out aseptic technique during an invasive procedure.
3. Points in aseptic technique for gowning.
   a. Dry the hands.
      (1) Reach into the sterile package and pick up the towel (Fig. 6: A).

(2) Take care that water does not drip onto the contents, and open the towel full length. Be careful not to touch the towel to the unsterile scrub clothing (Fig. 6: B).

(3) Dry both hands thoroughly; then one arm on one end of the towel; and the opposite end of the towel for the other arm (Fig. 6: C).

(4) To dry an arm, hold the towel in the opposite hand and, using an oscillating motion on the arm, draw the towel up to the elbow. Be careful that the towel does not touch your clothing or any other object until you have completed the drying process.

(5) Drop the used towel into a kick bucket when finished with it.

b. Pick up the gown. Reach down onto the sterile package and lift the gown directly upward, avoiding the edge of the wrapper (Fig. 6: D).

c. Open the gown.

(1) Step far enough away from unsterile objects to give a wide margin of safety.

(2) If the top of the gown should be dropped downward inadvertently, discard it. Never right a piece of linen once the wrong end has been dropped.

(3) Put on the gown without touching the outside of it with the bare hands. Remember, skin cannot be sterilized, only temporarily degermed.

(4) If uncertain whether the gown or hands have been contaminated, consider that they have. Discard the gown, and rescrub, if indicated.

d. Put on gown.

(1) Grasp the gown in one hand, lifting it directly up from the package (Fig. 6: D).

(2) Holding the neckband with both hands, gently shake the folds from the gown (Fig. 6: E).

(3) Slip the hands into the armholes, holding the hands upward (Fig. 6: F). [See "Note" below.]

[NOTE: *The person circulating should reach inside the gown to the sleeve seam, pull the sleeves on over the hands of the sterile person (Fig. 6: G), and tie the gown. He should only touch the outside of the gown at the line of the ties in the back. The person circulating must reach to the bottom of the ties to pick them up (Fig. 6: H). The sterile person does not touch the ties, but he can help by leaning slightly forward and swinging them free from the gown (Fig. 6: I and J).*]

Figure 6. Gowning procedure.

4. Gloving. Immediately after gowning, the sterile gloves are put on.

5. Purpose of the gloves. They are worn to complete the sterile dress, to enable the wearer to handle sterile supplies and equipment without contamination.

6. Points in technique.
   a. Put on gloves without touching the outside of them with the bare hands.
   b. Reach down into the package and pick up each glove, avoiding the edge of the wrapper.
   c. While pulling on the gloves, step away from the table on which the wrapper lies. This prevents contamination of the hand against the unsterile table in case the hand should slip.

7. Procedure for gloving (open method).
   a. With the left hand, grasp the cuff of the right glove on the fold. Pick up the glove and step back from the table (Fig. 7: A).
   b. Insert the right hand into the right glove and draw it on, leaving the cuff turned well down over the hand (Fig. 7: B).
   c. Slip the fingers of the right, gloved hand under the turned-back cuff of the left glove. Pick it up (Fig. 7: C).
   d. Insert the left hand into the left glove and pull it on, leaving the cuff turned well down over the hand (Fig. 7: D).
   e. Turn over a pleat of the cuff of the left sleeve, and hold it with the right thumb. With the fingers of the right hand, pull the cuff of the left glove over the cuff of the left sleeve. Avoid touching the gloved fingers to the bare wrist.
   f. Repeat for the right cuff (Fig. 7: E). [See "Note" below.]

[NOTE: A left-handed person may prefer to reverse the order; that is, put on the left glove first.]

8. Procedure for gloving (closed method). This method can only be used before the cuffs of the gown have been pulled into place over the hands.
   a. With the right hand, grasp the cuff of the left glove on the fold and step back from the table (Fig. 8: A).
   b. Place the glove, thumb side down and fingers pointed toward the elbow (Fig. 8: B), cuff of the glove even with the cuff of the gown (Fig. 8: C).
   c. With the left hand, grasp both cuffs through the fabric while grasping the cuff of the glove with the right hand (Fig. 8: D).

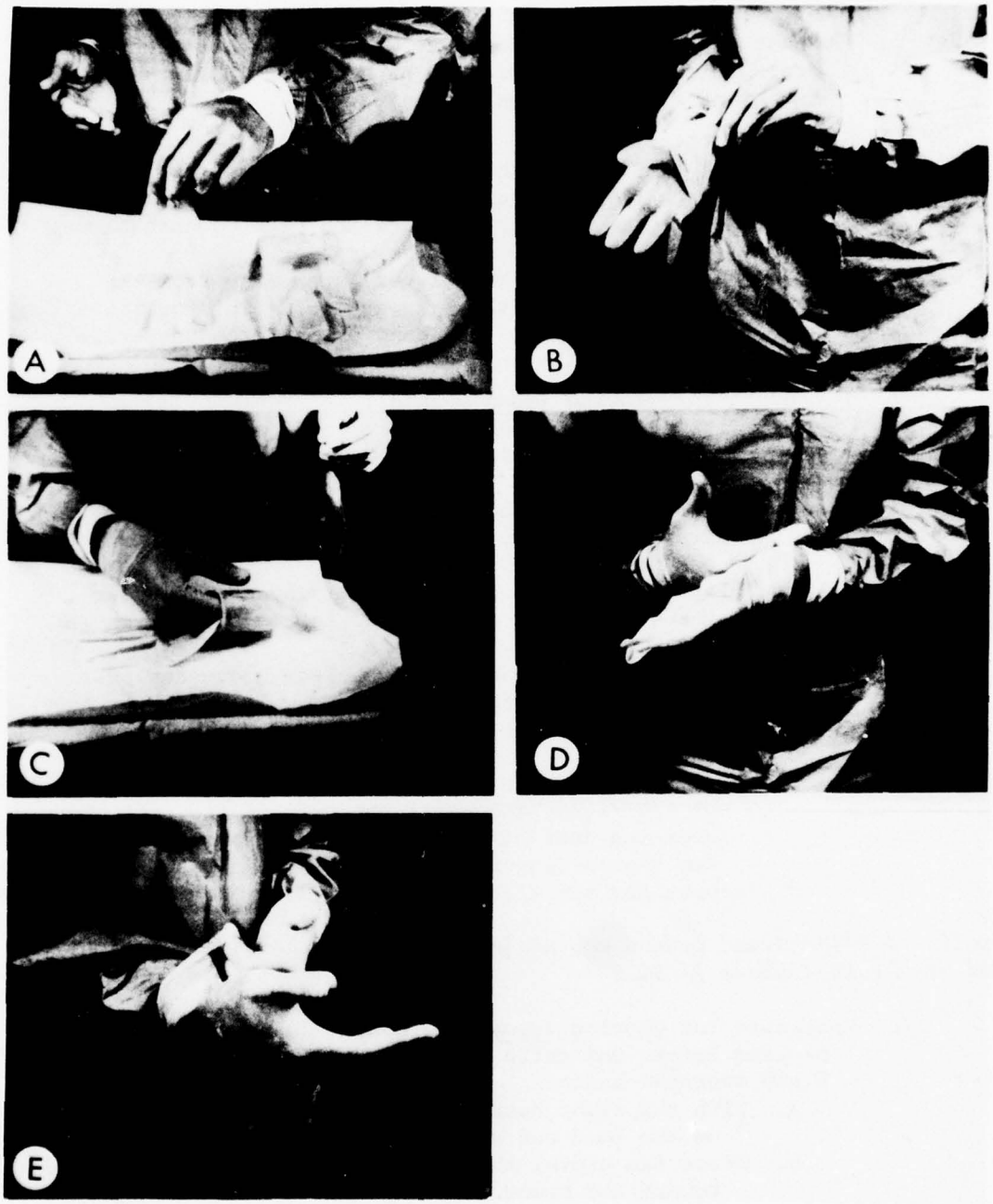

Figure 7. Gloving procedure (open method).

d. Pull the glove over the hand and pull both cuffs up to the wrist together (Fig. 8: E).
e. Repeat for the right hand (Fig. 8: F).

Prep Procedure--This routine is performed to prepare the patient's skin for an invasive procedure. It disinfects, or temporarily degerms, the skin by a combination of friction and germicidal agents (23, 59). For the areas usually prepped, refer to Figures 2 and 3 (in the report section: "The Cardiac Catheterization Team").

1. Check to see that all hair has been removed from the areas to be prepped. Touch up as needed.
2. Use aseptic technique.
3. Open sterile prep sets (one for each area to be prepped) containing: 2 metal cups, pickup forceps, and 4 x 4 in. sponges.
   a. Place 5 cc detergent povidone-iodine 7½% in one cup, and half fill with sterile saline.
   b. Quarter fill one cup with povidone-iodine 10%.
   c. Add sterile absorbent hand towel to each opened set.
4. Prep skin, from inner to outer aspect of area using a new sterile sponge for each circuit as follows:
   a. Scrub for five (5) min using sterile sponges soaked with 7½% detergent povidone-iodine.
   b. Blot with sterile towel.
   c. Paint, using sponge or forceps, with solution of 10% povidone-iodine and allow to dry completely (7, 8).

Draping Procedure--

1. Inguinal regions (for Judkins approach)
   a. Following the standard surgical prep, a small drape is placed over the patient's genital area to preserve modesty (Fig. 9: A, B).
   b. The femoral artery is palpated 1-2 in. below the inguinal ligament, and a small aperture sterile drape is positioned directly over the pulsation (Fig. 9: C). If the femoral vein is to be used, the aperture may be moved slightly medially and distally.

      The ideal drape has a self-adhesive back which maintains position and sterility during patient rotation.
   c. Sterile nonabsorbent drapes are positioned on all four sides of the steri-drape, approximately 1-2 in. from the aperture (Fig. 9: D). The sterile drapes are attached to each other and the steri-drapes by towel forceps (Fig. 9: E, F).
   d. Both inguinal areas are thus isolated with sterile drapes.

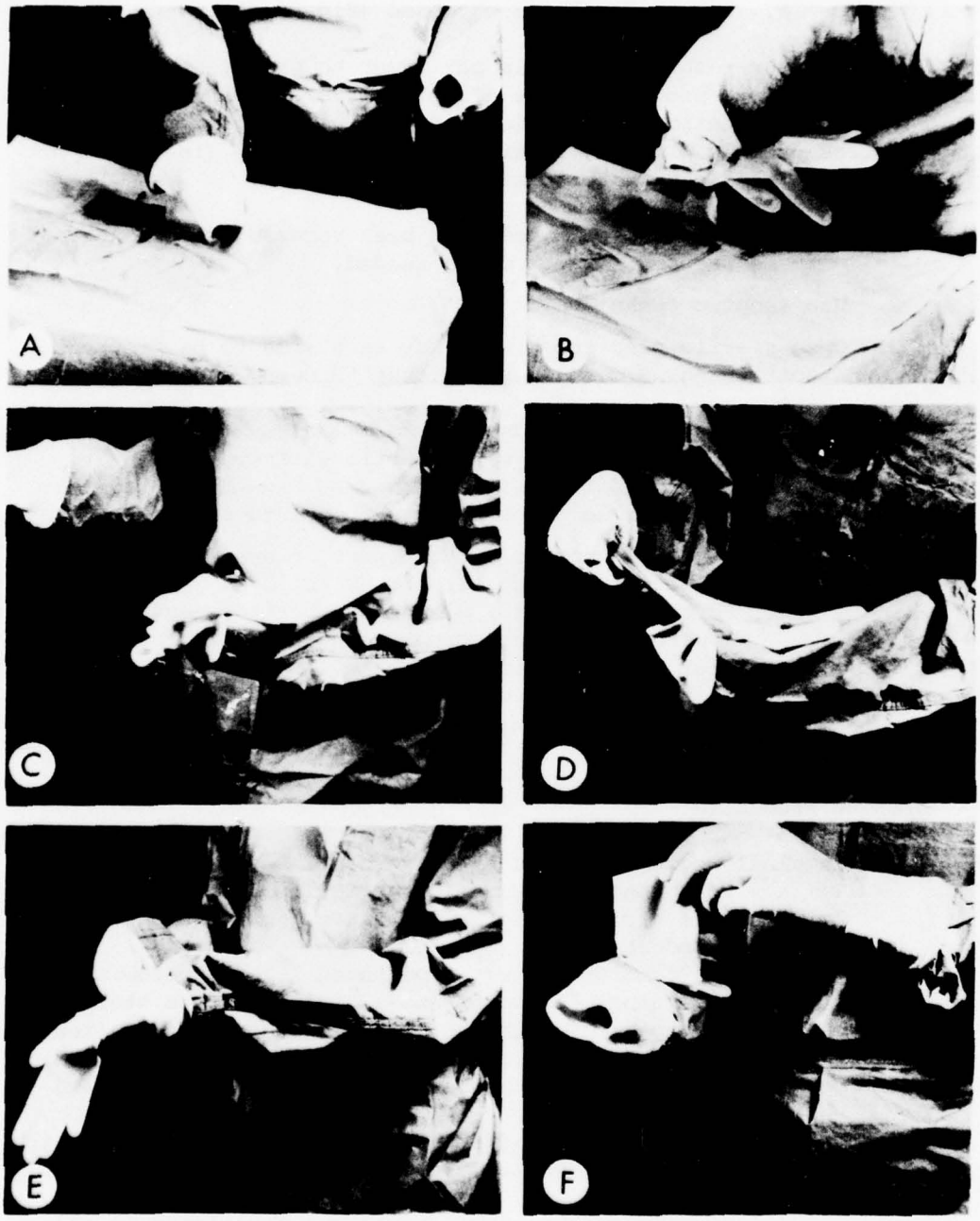

Figure 8. Gloving procedure (closed method).

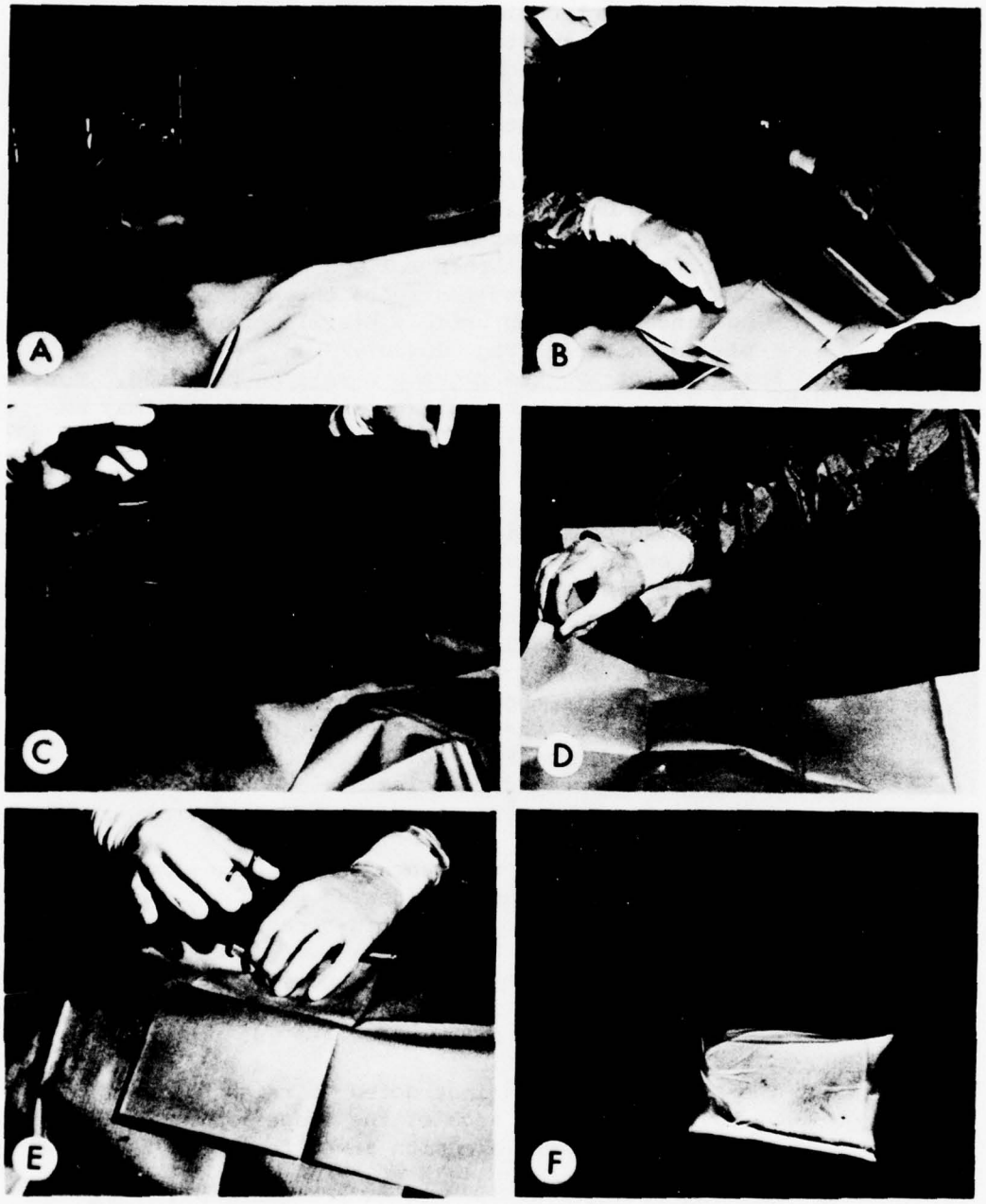

Figure 9. Draping procedure (inguinal area).

2. Antecubital areas (for Sones approach)
    a. After the inguinal regions have been draped, the circulating technician, or nurse, gloves and takes a 4-in. stockinette, closed at one end and rolled, from the scrub technician.
    b. The patient is asked to extend his fingers and, while keeping his arm straight, lift it from the arm board (Fig. 10: A).
    c. The stockinette is rolled down the patient's arm, with care being taken not to drag the stockinette over the prepped area (Fig. 10: B, C).
    d. The scrub technician then rolls a second stockinette over the first, and instructs the patient to continue holding his arm up until a sterile drape can be placed under it (Fig. 10: D).
    e. For arteriotomy, the right arm will be prepared. For electrophysiologic evaluation, the left arm may be draped instead of, or as well as, the right.

3. Completing the drape
    a. For inguinal approach, the scrub technician places a nonabsorbent, disposable, bilaterally fenestrated sheet on the patient and opens it to complete the sterile field.
    b. For arm approach, the scrub technician passes the end of a sterile nonabsorbent sheet to the circulating technician who spreads it over the feet of the patient, while the scrub technician spreads the upper end over the patient's shoulders and under the prepped arm (Fig. 10: E, F).
    c. The patient is asked to relax his arm as the scrub technician positions it on the covered arm board (Fig. 10: G).
    d. The sheet is gathered on each side of the patient's arm, as near to the shoulder as possible, and clipped together over the mid-biceps with towel forceps (Fig. 10: H).
    e. A smaller nonabsorbent drape is positioned over the shoulder and the first towel forceps, with the edge of the drape being about 4-6 in. proximal to the elbow (Fig. 10: I).
    f. The patient is again instructed to raise his arm while the leading edge of the drape is fastened snugly around the arm with towel forceps (Fig. 10: J and K).
    g. The arm is again positioned on the arm board. The patient should always be asked if the draping is comfortable (Fig. 10: L); and, if it is not, then the draping should be readjusted.

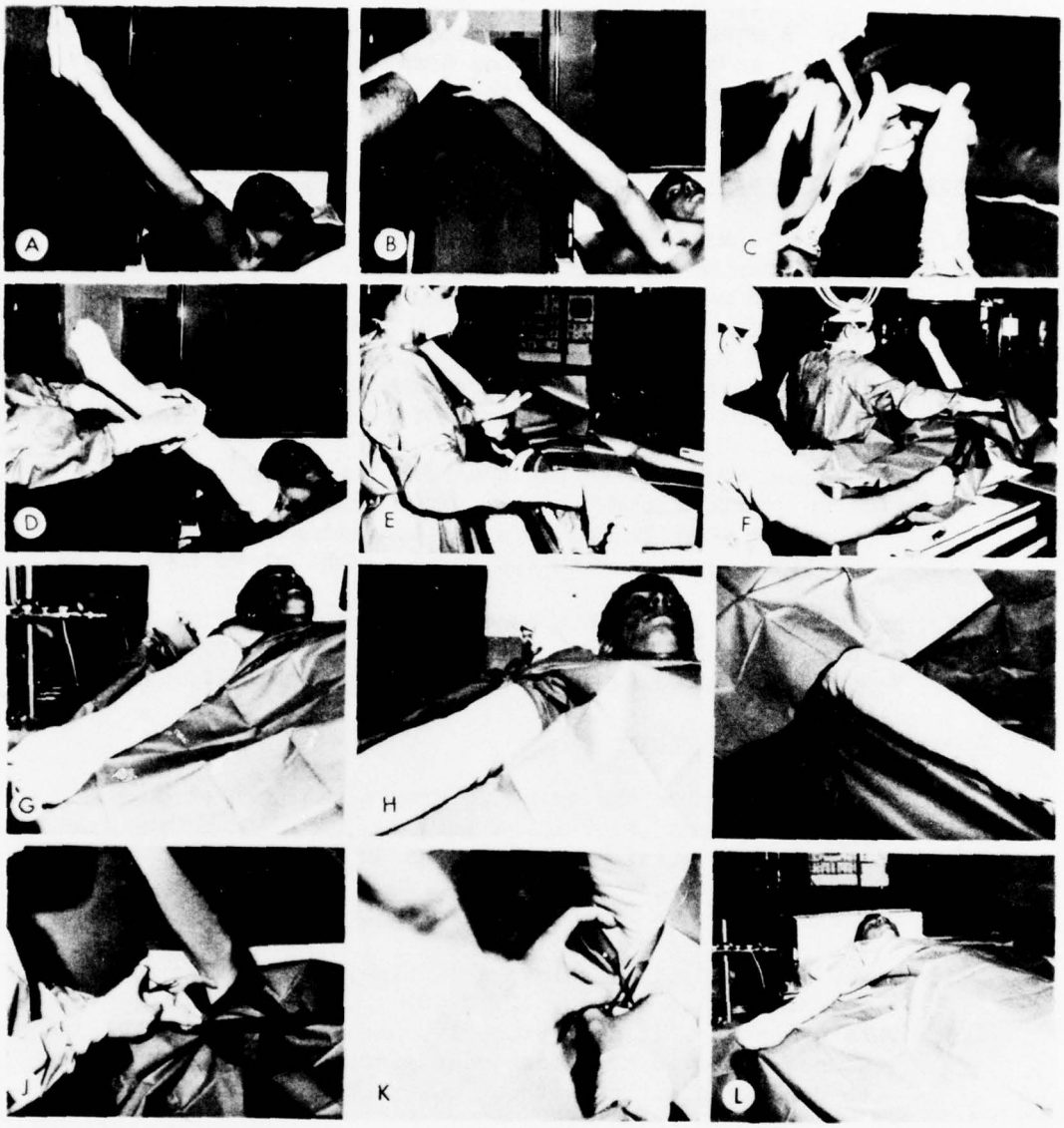

Figure 10. Draping procedure (arm).

h. Another drape sheet is placed over the patient's legs and the foot of the table to complete the sterile field.

i. A sterile disposable nurse's cap is placed over the under surface of the x-ray tower to prevent contamination of the field when the tower is lowered (52).

Dressing the Cardiologist--

1. Provide a sterile absorbent towel for hand drying.
2. Grasp a gown by the top. Place hands at outside shoulder seams and gently shake gown open (Fig. 11: A)
3. Hold gown so that cardiologist can "walk into" it, facing you (Fig. 11: B).
4. Pull shoulders of gown up to cardiologist's shoulders, being careful not to touch any part of his head with gloves (Fig. 11: C).
5. Circulator will secure the gown closures (Fig. 11: D).
6. Pick up doctor's right glove, place fingers under the cuff extending your thumbs to avoid contamination, and spread the glove opening with the thumb of the glove toward the doctor (Fig. 11: E).
7. As the doctor places his hand into the glove, draw the cuff up over the cuff of his gown (Fig. 11: F).
8. Repeat the procedure for the left glove (Fig. 11: G).

Removing Gown and Gloves--

1. Circulator unties the gown and grasps the gown at both shoulder seams (Fig. 12: A).
2. Pull the gown straight over the hands in one smooth motion (Fig. 12: B).
3. Removing the gown causes the gloves to cuff over the hands (Fig. 12: C).
4. Grasp the cuff of one glove at a time, and pull it off over the fingers (Fig. 12: D, E).
5. This procedure, if done properly, permits an individual whose gown and gloves have been contaminated during a procedure to don fresh attire without rescrubbing to finish the case.

Contaminated Glove--

1. Grasp the cuff of the affected glove at the wrist (Fig. 13: A).
2. Pull the glove over the hand, being careful not to contaminate the hand (Fig. 13: B).
3. A new glove can now be donned by the open method.

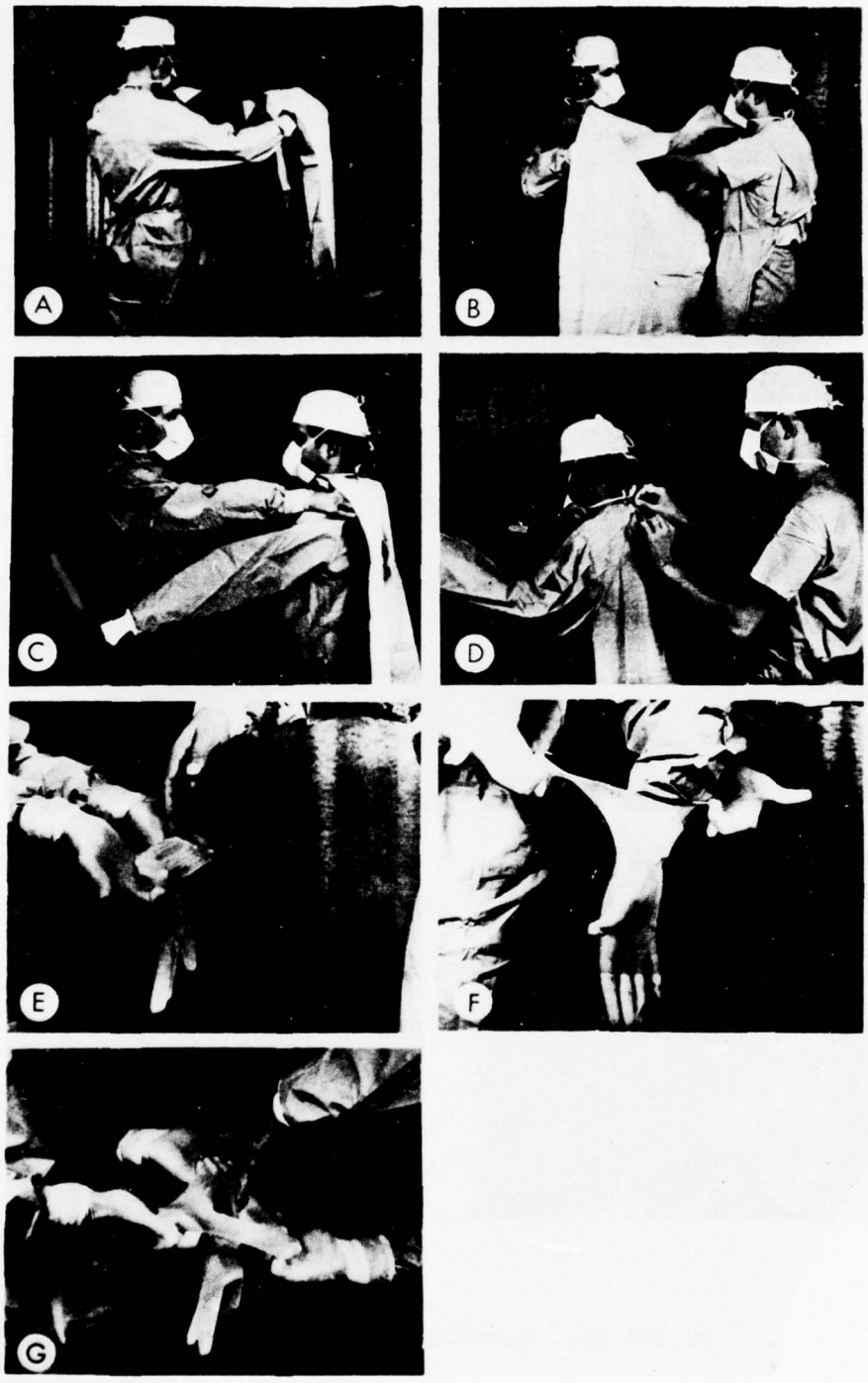

Figure 11. Dressing the physician.

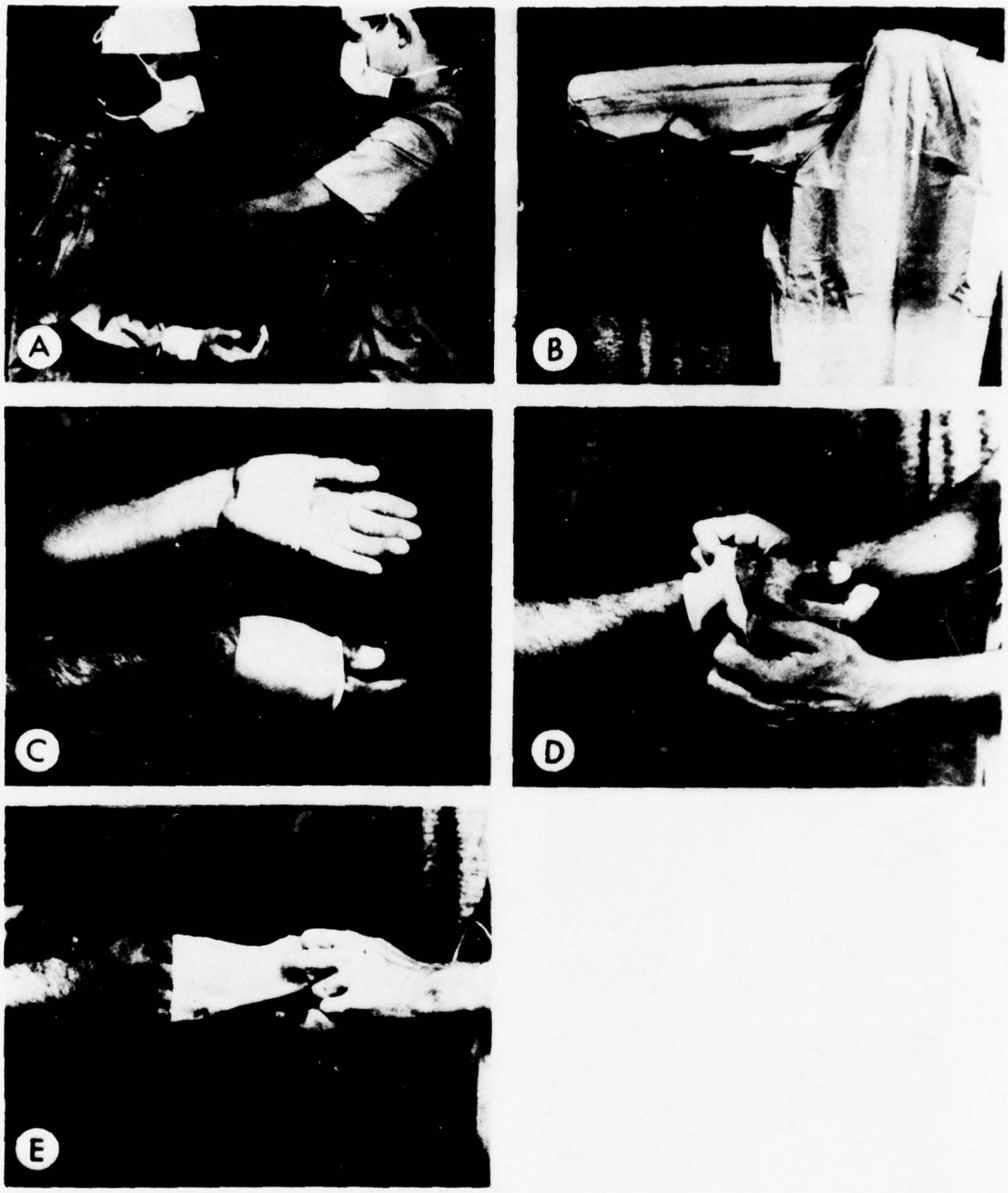

Figure 12. Removing gown and gloves.

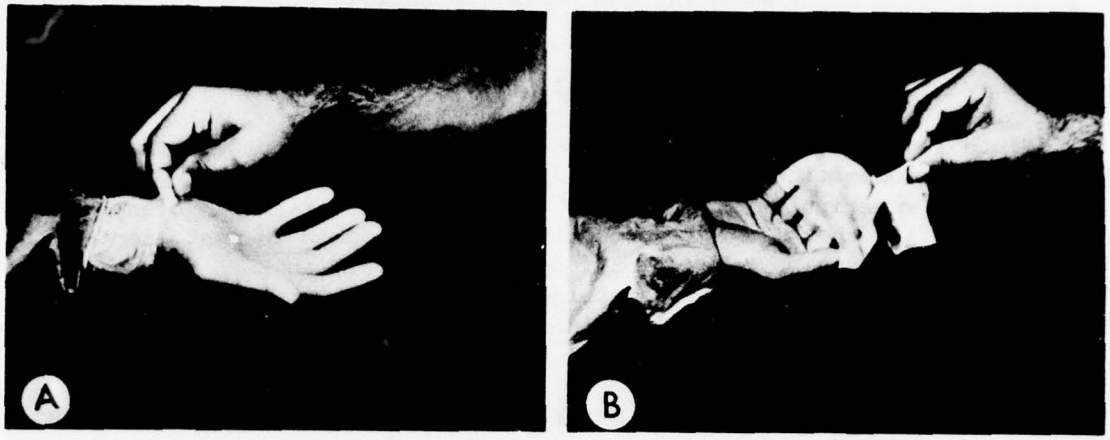

Figure 13. Removing contaminated glove.

Summary

An overview of the process of infection and aseptic technique has been presented here as a behavior pattern directed at preventing infection. The material is not intended to be comprehensive. Any good microbiology text has further information about infective processes. Aseptic principles are discussed fully in handbooks and texts relating to the operating room and central sterile supply areas.

Environmental controls for the laboratory include precautions regarding wearing apparel, the ambient environment, and bacteriologic considerations. In this report, aseptic technique has been discussed with specific applications for the cardiac catheterization laboratory.

ELECTRICAL AND RADIATION SAFETY

Electrical Safety

Since the protective covering of the body is interrupted during cardiac catheterization, there is the risk of micro shock to the heart--resulting in ventricular fibrillation and death. The risk is potentiated by the fact that leakage currents are quite common in most electrical equipment. In addition to designating the laboratory an ESPL (Electrically Susceptible Patient Location) requiring only Type "A" electrical apparatus, the following methods have been devised to protect the cardiac catheterization patient from risk currents:

1. A good quality grounding system is required, and is tested weekly.

2. An adequate electrical isolation system is necessary, and all equipment is tagged to indicate acceptability.

3. All electrical equipment should be frequently monitored for leakage currents. Limits of acceptability are:
   a. Ground attached--no leakage.
   b. Ground broken--10 μa (microamperes) (74).

4. Safety features are incorporated in equipment design and manufacture (27, 74, 75, 82, 83).

5. A monthly safety check of electrical equipment is made by the bioelectric engineer or his representative, and the results are recorded on Forms Nos. 18 and 19 (Appendix A). All findings are reported semiannually to the Director and Officer in Charge (OIC) of the laboratory. Discrepancies are reported at once. Not only must the equipment checklist be completed, but the following items must be evaluated:
   a. Three-prong plugs and receptacles are required on every piece of line-powered equipment. Two-prong "cheaters" are not permitted in the laboratory.
   b. All wiring, in the laboratory wall sockets and cords, is visually checked.
   c. Extension cords are not permitted.
   d. The resistance of all power cords is checked to assure continuity of each of the three wires.
   e. Conductive flooring, if present, is checked every 3 months.

f. The energy outputs of the defibrillators are checked, as well as monthly conductivity tests, and semiannual x-rays of all defibrillator paddles, cables, and connector assemblies.

6. Discrepancies are corrected whenever detected.

   a. Unacceptable leakage currents are isolated and corrected by the electronic technician, engineer, or medical maintenance person. Catheterizations are not performed if there are any unacceptable leakage currents.

   b. Defective cords and/or wiring are repaired or replaced upon detection.

   c. Malfunctioning electrical equipment is repaired as soon as possible.
      (1) The electronic technician, engineer, and/or medical maintenance person will handle all repairs that are within their capabilities.
      (2) Local contract maintenance may be performed for some equipment.
      (3) For particularly sensitive problems, equipment may be sent to the manufacturer for repair.

7. Further general precautions, specified by the Association for the Advancement of Medical Instrumentation (AAMI) Safety Standard for Electromedical Apparatus and/or Air Force Regulation, include (27, 44, 62, 63, 70, 74, 75, 82):

   a. A foreign electrical conductor to the heart should be intentionally contacted only by:
      (1) Gloved hands, or
      (2) Isolated patient connections (Type A), or
      (3) Combinations of isolated patient connections as explicitly directed by the cardiologist; and
      (4) A properly functioning defibrillator should be available.

   b. Assigned personnel should be thoroughly trained in the use and operator maintenance of electromedical apparatus, and should read the operator's manuals for all the equipment they operate.

   c. An operator's manual should be on file for each type of electromedical equipment in the facility.

   d. Brief operating instructions for safe and proper operation of electronic equipment should be visibly posted near the apparatus.

e. When two or more electrical devices are connected to the patient simultaneously, they should be plugged into adjacent receptacles instead of receptacles separated by more than two or three feet.

f. Mop or wipe up liquids spilled in areas of electrical equipment use as soon as possible.

g. When practical, do not touch an electrical device and the patient (or his catheter) simultaneously.

h. Arrange power cables to minimize the possibility of someone's tripping over them.

i. Avoid damaging power or line cables by dropping heavy objects on them or rolling portable equipment over them.

8. Some specific precautions for the safe use of electrical and/or electronic monitoring devices and defibrillators include:

a. Be sure any apparatus used for electrical and/or electronic monitoring has a current Type A equipment certification tag.

b. Immediately report monitors producing tracing or sweep irregularity, alarm malfunction, or rate meter inaccuracy.

c. Immediately report defibrillators which do not meet all inspection or testing requirements.

d. If a defibrillator malfunctions in any way, remove it from use at once.

e. Insure that all personnel who may use a defibrillator have passed an advanced life-support course, and have had on-the-job training, or other acceptable preparation for the safe and effective use of the equipment.

f. If ventricular fibrillation occurs in a patient who has an electrode catheter, in or near the heart, which is connected to a foreign electrical connection--first, care for the patient, and then:

(1) Consider the fibrillation to have been electrically induced until all testing efforts to find cause of fibrillation are exhausted.

(2) Leave the equipment configuration "as is," as much as possible, for an engineering analysis (74).

Radiation Safety

The radiation dose to the patient, and concomitant dose to personnel via radiographic procedures, is greater in the cardiovascular laboratory because of the high milliamperage requirements of cinefluorography. Moreover, image intensifiers with automatic brightness control may experience a rise in x-ray tube current and potential, unknown to the user, thus causing an increased exposure to the patient, as well as to team members close to scatter (92).

Exposure to all involved can be mitigated by conscientious and deliberate reduction of fluoro- and cine-time. However, measuring the tabletop exposure rate at regular periods is important to ascertain changes in the unit's peak kilovoltage (kV) and milliamperage (mA). Corrective action is taken if necessary.

The tabletop exposure rate is measured with a standardized aluminum phantom in the useful beam, and a record of these measurements is retained for future reference and comparison. Scatter radiation measurements can be taken with a 22 cm phantom composed of Prestwood or water.

For control of excessive radiation exposure, a useful technique is to use as small a radiation beam as possible to derive satisfactory diagnostic information. This beam size is accomplished by proper beam collimation via collimators, adjustable diaphragm, or shutters which are an inherent part of the x-ray tube assembly. A properly restricted beam is manifested as an unilluminated peripheral margin on the television monitor. Scatter radiation can be much greater when the shutters are open wide than when the beam is coned-down.

Reduction of patient skin and gonadal dose is afforded by use of a lead absorber (lead apron or sheet), placed on the tabletop between the patient and the undertable x-ray tube target. The fluoroscopic table with wooden cradle decreases patient exposure by increased distance from the x-ray tube; however, scatter is increased.

The following fundamental preventive measures and precautions can be taken by catheterization team members to minimize their radiation exposure:

1. Wear a protective apron, of at least 0.25 mm lead equivalent. The apron should be hung, unfolded, when not in use. Aprons should be checked for cracks by taking x-ray pictures of them annually.

2. Keep hands out of the x-ray beam.

3. Wear <u>two</u> x-ray dosimeters--one on the collar to measure eye exposure; and the other under the lead apron, between the waist and the shoulders, to measure whole body and skin expos e. The dosimeters are provided and evaluated by the Health ysics Branch (58, 92, 96).

4. Personnel radiation exposure records provided by the Health Physics Branch are filed for future reference, and current records maintained by the nurse (OIC).

5. Unusual results are promptly investigated and the cause documented. A signed statement from the individual(s) involved, acknowledging the documentation, should be obtained for reference in case legal complications arise.

Radiation exposure limits have been published in the Code of Federal Regulations, Title 10, Part 20 (10 CFR 20) (96), and apply to personnel who work in the cardiovascular laboratory. For people over eighteen years of age and who are not pregnant, maximum permissible ionizing radiation dose per calendar quarter is the following:

1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads: 1.25 rems

2. Hands and forearms; feet and ankles: 18.75 rems

3. Skin of whole body: 7.50 rems

In some instances, these limits may be exceeded; and they are specified in 10 CFR 20 (96: pp. 8-9).

Scatter radiation from fluoroscopic tables with wooden patient cradles will vary, depending upon the position of the cradle: e.g.,

1. When the patient cradle is mechanically rotated with the patient's right arm elevated (right anterior oblique position), the chest level radiation exposure to the cardiologist, and other team members to the patient's right, is significantly increased.

2. When the position is left anterior oblique, the exposure to individuals opposite the cardiologist at the patient's left side, is significantly increased.

The following precautions will help reduce radiation exposure:

1. Rotate personnel.

2. Remain as far as possible from the fluoroscopic table whenever permissible, without compromising the patient's health or aseptic principles.

3. Be sure that the location of the cardiac monitoring equipment and operator is relatively distant from the fluoroscopic table, and use a portable shield when possible.

4. Use videotape recording to obviate repeat examinations, thus avoiding additional irradiation of all involved (92).

Proper functioning of the radiologic equipment is essential:

1. Contract maintenance by the manufacturer should provide for periodic routine checks and immediate emergency service.

2. After major repairs or x-ray tube replacement, scatter radiation must be evaluated and found to be safe by a radiation protection officer before a procedure is done (96: pp. 14-15).

As a general precaution, all team members should keep informed on current State and Federal radiation control regulations to assure compliance. This additional action, plus implementation of the foregoing preventive measures, will ultimately assure a successful radiation protection program in the cardiovascular laboratory (5, 10, 18, 58, 92, 96).

Summary

The importance of the proper functioning of electrical and radiographic equipment in the laboratory cannot be overemphasized. The safety measures discussed are for the protection of the patient and the cath team members who use the equipment day after day. An errant electric current can cause immediate injury or clinical death, while unsuspected high radiation exposure can cause irreversible physiologic damage.

Acknowledgment

Grateful appreciation is expressed to Dr. A. J. Thompson (92) for some of the material in this section from the Basic Organization of the Cardiovascular Laboratory, SAM-TR-75-39. (Dr. Thompson's present address is footnoted in the "Preface," on page 1.)

SUPPLIES AND EQUIPMENT

Introduction

Lists of the supplies and equipment stocked for and used in the cardiovascular laboratory are included in this report section. Stock levels are sometimes arbitrary, but those shown here should serve as a guide. Catheters and accessories are listed by brand name, size, and catalog number whenever possible. A brief description of some of the catheters follows the listing. Specific procedures are given for the care of catheters after a procedure. The concluding pages of this section deal with the composition and setup of sterile catheterization trays used in this laboratory.

In the near future, we will incorporate exercise ergometry Fick output and thermal dilution studies into the routine catheterization procedure. Those studies will require an inventory modification to list additional supplies and equipment not included in this report.

STOCK LEVELS OF SUPPLIES AND EQUIPMENT

The stock levels listed on the following pages are for one month of cardiovascular laboratory operation, and can change--depending on the number and types of procedures undertaken:

ITEM(S)	STOCK LEVEL
In the Scrub Room	
Caps, for females	1 box of 500
Caps, for males	2 boxes of 100
Masks, aseptex blue	2 boxes of 50
Masks, filter, pouch	2 boxes of 50
Scrub brushes, Accu-Dine	2 boxes of 20
In Central Supply	
Dresses, scrub	4
Scrub suits	12 pairs
On the Crash Cart	
1. Top of Cart	
Defibrillator, Life-Pak	1
Oxygen tank: small	1
large (backup)	1
Suction machine, with suction catheter attached	1
Support boards for Rotacor	2
2. Bottom of Cart	
Airway, large:	
S-Tube	1
Plastic	3
Rubber	1
Ambu converter (adapter)	1
Endotracheal tubes:	
8 mm	1
8.5 mm	1
9 mm	1
Flashlight	1
Hemostat, rubber tipped	1
Laryngoscope, large and small blades	1 each
Lidocaine jelly	1 tube
Normal saline, pour bottle	1
Oxygen administrators:	
Catheter	2
Mask	1
Nasal cannula	1
Stylette, for endotracheal tubes	1
Suction catheters	3
Suction tip, metal (tonsil type)	1
Syringe, 10 cc plastic	
Tongue blades:	
Disposable	5
Padded	1
Drawers of Nurse's Cabinet	
Ace wraps, 3 in.	4
Blood pressure cuff	1
Drinking cups, disposable	6
Elastoplast, 4 in.	2 rolls
Electrode paste	2 tubes
Electrodes, disposable	1 box of 25
Emesis basin	1

(Cont'd. on facing page)

Stock Levels of Supplies and Equipment (Cont'd.)

ITEM(S)	STOCK LEVEL
Flashlight	1
Masking tape	2 rolls
Neosporin cream	2 tubes
Sponges, 4 x 4, sterile	1 box of 25
Sponges, 4 x 4, unsterile	12
Stethoscope	1
Tourniquet	1
Cabinet Under Sink	
Arm board	1
Benzoin, tincture	32 oz
Betadine Paint, 10%	2 bottles
Betadine Scrub, 7½%	4 bottles
Hydrogen peroxide	1 bottle
Linen, unsterile:	
Hand towels	12
Pillow cases	4
Sheets	6
Needle destroyer	1
Prep set:	1
2 boxes of 5 blades	
1 pkg 4 x 4 in. sponges	
1 roll masking tape	
In Sterilizer Room	
1. Equipment	
Basins	2
Detergicide	1 gal
Flusher	1
Rotacor cradle, spare	1
Syringes, disposable, 10 cc	2

2. Sterile solutions	Amount (cc)	
D5W	250	6
D5W, soft pack	500	2
D5W	1000	3
D5NS, soft pack	500	1
D5 ½ NS	250	1
D5 ½ NS	500	2
D5 ½ NS	1000	2
Lactated Ringer's	1000	3
Normal saline, pour bottle	500	8
Normal saline, soft pack	250	15
Normal saline	250	6
Normal saline, soft pack	500	2
Normal saline	1000	8
Vasoray	50	10
Vascoray	200	8
Water	1000	8

INVENTORY OF STERILE SUPPLIES

Linen, disposable	
Sheets	20
Towels, absorbent	40
Towels, nonabsorbent	20

(Cont'd. on next page)

Inventory of Sterile Supplies (Cont'd.)

ITEM(S)	STOCK LEVEL
In Metal Supply Cabinet	
Blades, #11	1 box of 6
Blades, #15	1 box of 6
Catheterization trays	4
Cordis Injector Syringe Sets	3
Guide wires:	
0.035 straight	5
0.035 J	5
0.038 straight	12
0.038 J	12
His study connector wires	2 sets
His study trays	2
Intracaths, 14 ga	10
Introducer sets:	
Cordis	1 box of 10
UMI (Universal Medical Instrument Corp.)	1 box of 10
Light handles	4
Pick ups	3
Prep sets	6
Pressure transducer cables	4
Pressure tubing	1
Sponge basin	1
Socorex set, 10 cc	2
Steri drapes, small aperture	1 box of 10
Stockinettes, 4 in.	5 peel packs (2 per pack)
Sutures:	
4-0 Chromic	1 box of 36
4-0 Nylon	1 box of 12
6-0 Prolene	1 box of 36
4-0 Silk, strands	1 box of 12
5-0 Tevdek	1 box of 36
6-0 Tevdek	1 box of 36
Syringes, glass:	
10 cc	10
30 cc	6
In Wooden Supply Cabinet	
Adapters:	
Male to male	2
Rotating	2
Cournand needles:	
0.035	2
0.045	2
18 ga, long local	2
18 ga, thin wall	2
Grommets, rubber	2 peel packs (2 per pack)
Hats, nurses'	6
Instruments:	
Clamps--	
Artery, small	2
Bulldog	2 (sets of 2)
Cooley	2
Towel	3
Forceps, skin	1
Hemostats--	
Curved	2
Straight	4

(Cont'd. on facing page)

Inventory of Sterile Supplies (Cont'd.)

ITEM(S)	STOCK LEVEL
Knife handle	1
Needle holder	3
Probe	2
Retractor, cat-claw	2
Scissors--	
Iris	4
One-point sharp, suture	2
Manifolds:	
Morse	1
USCI (a division of C. R. Bard, Inc.)	3
Extra cores	2 (sets of 3)
Transducer dome hub, spare	5
Tubing:	
Dye tubing	10
Saline tubing	10
Volutrol	5
In Glass Supply Cabinet	
Extension tubing	8
Needles:	
Butterfly, 19 ga	5
Longdwell, 20 ga, disposable	5
18 ga, disposable	30
20 ga, disposable	30
22 ga, disposable	30
23 ga, disposable	30
26 ga, disposable	30
Stopcocks, 3-way, disposable	5
Syringes:	
Viamonte	1 box of 10
2½ cc, disposable	30
5 cc, disposable	40
20 cc, disposable	40
30 cc, disposable	20
T.B., disposable	30

CATHETERS AND ACCESSORIES

Within this report section, items are grouped by brand name. Where possible, the catalog numbers (assigned by the General Services Administration [GSA], and by the respective manufacturer) are listed, as well as the size and length of the individual items:

TYPES OF CATHETERS	GSA NO.	CATALOG NO.
A. CORDIS [Cordis Corp., Miami, Fla.]		
PIGTAIL (Femoral-Ventricular)		
Open-end, 12 side holes		
8 French, 110 cm	6515L209563	523-850
FEMORAL LEFT CORONARY A[1]		
Open-end, no side holes		
8 French, 100 cm, 4 cm tip	6515L209562	523-840
8 French, 100 cm, 5 cm tip	6525C0770LL	523-842
8 French, 100 cm, 6 cm tip	6515L224983	523-844

(Cont'd. on next page)

Catheters and Accessories (Cont'd.)

TYPES OF CATHETERS	GSA NO.	CATALOG NO.
FEMORAL RIGHT CORONARY A[1]		
Open-end, no side holes		
8 French, 100 cm, 4 cm tip	6515C0770LD	523-841
8 French, 100 cm, 5 cm tip	6515C0770LM	523-843
8 French, 100 cm, 6 cm tip	6515L224984	523-845
FEMORAL LEFT CORONARY B[2] (Multipurpose)		
Open-end, no side holes		
8 French, 100 cm, Type I	6515L224985	524-840
8 French, 100 cm, Type II	6515L227257	524-842
8 French, 100 cm, Type III	6515L224170	524-844
MULTIPURPOSE A-2[6]		
Open-end, 2 side holes		
8 French, 100 cm	6515L229047	521-842
BRACHIAL CORONARY B[5]		
Open-end, no side holes		
8 French, 100 cm, Type II	6515L221059	525-882
8 French, 100 cm, Type III	6515L221644	525-883
BIPOLAR PERVENOUS ELECTRODE - SEMI-FLOATING		
4 French, 100 cm		370-110
VESSEL DILATOR		
8 French, 0.038 Guide	6515L209564	501-200
PERCUTANEOUS CATHETER INTRODUCER		
7 French		501-607

B. DAMATO [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]

TRIPOLAR HIS BUNDLE ELECTRODE		
6 French, 125 cm		002854
7 French, 125 cm		002853

C. EPPENDORF [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]

7 French, 100 cm		001371
8 French, 100 cm		001373

D. FOGARTY (EMBOLECTOMY) [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]

4 French, 40 cm	6515L203182	12-040-4F
4 French, 80 cm		12-080-4F

(Cont'd. on facing page)

Catheters and Accessories (Cont'd.)

TYPES OF CATHETERS	GSA NO.	CATALOG NO.
E. GENSINI [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
7 French, 100 cm		001784
6 French, 80 cm		001780
6 French, 100 cm		001781
5 French, 80 cm		001777
F. GOODALE-LUBIN [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
7 French, 100 cm		001462
7 French, 125 cm		001463
8 French, 100 cm		001465
8 French, 125 cm		001466
G. GOETZ (BIPOLAR) [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
6 French, 100 cm		007156
H. GUIDE WIRES [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
0.035, 145 cm, straight	6515L227748	007046
0.038, 145 cm, J	6515L227746	007044
0.035, 145 cm, J	6515L227745	007042
0.038, 145 cm, straight (The straight guide wires have 3-cm floppy tips; nonmovable cores)	6515L227747	007048
I. HEXAPOLAR (ELECATH) [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
6 French, 110 cm		26-7366
J. JAMESON ELECTRODE PROBE [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
2 French, 100 cm		001537
K. LEHMAN [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
7 French, 80 cm		001262
8 French, 100 cm		001406

(Cont'd. on next page)

Catheters and Accessories (Cont'd.)

TYPES OF CATHETERS	GSA NO.	CATALOG NO.
L. MYLER™ RIGHT HEART CATHETER [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
7 French, 125 cm		004015
M. NIH (Nat'l. Inst. of Health) CATHETER [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
7 French, 100 cm		001358
8 French, 100 cm		001362
N. QUADRIPOLAR (HIS BUNDLE) (USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
6 French, 125 cm		002943
7 French, 125 cm		002944
O. SONES [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
8 French, 80 cm, Type I		007538
8 French, 100 cm, Type I		007539
7.5 French, 80 cm, Positrol		007561
7.5 French, 100 cm, Positrol		007562
8 French, 80 cm, Brachial Coronary Lt X-S		007770
P. SWAN-GANZ (EDWARDS LABS) [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
5 French, 110 cm		93-100-5F
7 French, 110 cm		93-111-7F
Q. UMI (Universal Medical Instrument Corp.): PERCUTANEOUS CATHETER INTRODUCER SETS [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
Set includes: Teflon sheath, 14 cm long, 0.007 cm wall thickness; Teflon dilator, 20 cm with proximal flare; Stainless steel guide wire, 40 cm long, 3 cm flexi-tip		
6 French	6515L228049	1201-00-06
7 French	6515L228050	1201-00-07

(Cont'd. on facing page)

Catheters and Accessories (Cont'd.)

TYPES OF CATHETERS	GSA NO.	CATALOG NO.
R. USCI™ (ELECTRODE CATHETERS) [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
8 French, 125 cm, micro-tip (experimental)		
8 French, 125 cm, micro-tip (double tip)		
S. ZUCKER [USCI, a Division of C. R. Bard, Inc., Dallas, Tex.]		
6 French, 100 cm		001510
6 French, 100 cm, quadripolar with lumen, special order		

Descriptions of Some Catheters

The sequence and the number of catheters described do not necessarily correspond with those in the foregoing list.

Cordis

1. Bipolar pervenous electrode, semi-floating. This is a semi-floating type of catheter for short-term pacing with all external pacemakers. It comes pre-packed with cannula set and connector.

2. Cordis coronary catheters. The Cordis pre-formed femoral right and femoral left catheters are used for the selective catheterization of the coronary arteries. Coronary-seeking tip configurations, set in a redesigned moldable positive control catheter, implement rapid and consistent selective coronary catheterization. When properly positioned, the catheters will remain in place for anatomic and dynamic filming in multiple positions. These catheters have multiple curves, open ends, and no side holes. They use a 0.038 in. diam. guide wire.

3. Multipurpose Cordis. This catheter has a single curve, open end, and two side holes. A wire guide with a 0.045 in. diam. can be passed through this catheter.

Damato, tripolar catheter. This catheter has three (2-mm) platinum electrodes--one located at the distal tip; the second, 1 cm proximal to the distal electrode; and the third, 2 cm proximal to the tip electrode. Construction consists of fatigue-resistant wires incorporated within a woven Dacron base with a smooth, polyurethane finish coating for optimal durability and reliability of performance. Each distal tip curve was designed by Dr. Damato for ease in positioning the tip for His Bundle electrograms.

This tripolar electrode may be introduced into the vascular system by cutdown or percutaneously, using a USCI #8536 (6 French) or #8537 (Desilets-Hoffman Percutaneous Catheter Introducer), and advanced to the desired intracardiac position via ECG or fluoroscopy.

Electrode catheter, Platinum. This electrode catheter is constructed of a smooth bore nylon core with a reinforced Dacron braid incorporating a pure platinum electrode ring at the distal tip flush with the catheter surface. The proximal electrode terminal consists of a metal band located near the Luer-Lok fitting to accommodate alligator clamp connnections to recording instrumentation. The catheter lumen is one size smaller than a comparable nonelectrode catheter. This instrument is used primarily for ascorbic acid dilution and hydrogen ion studies in

the diagnosis of intracardiac shunts. In conjunction with these studies, blood sampling and pressure data can be easily obtained. (These studies are only rarely done in this laboratory.)

Eppendorf catheter. The Eppendorf catheter is constructed of woven Dacron and is designed to provide additional radiopacity on a thin-wall catheter with a minimum of lumen compromise. The woven Dacron construction allows for 20 cm of reinforcing nylon sheath in the hub area for additional support during pressure injections. The closed distal tip is completely radiopaque. The 6 woven eyes are arranged in 3 laterally opposed pairs within the first 1.5 cm of the tip.

The Eppendorf catheter is especially useful for angiocardiography and arteriography studies.

Fogarty catheter. The Fogarty arterial embolectomy catheter is a single lumen balloon catheter instrument designed specifically for embolectomy procedures involving delicate vessels. The distal end is a short soft tip, allowing easy arterial insertion and minimizing trauma, artero-puncture, and plaque avulsion. The pliable vinyl body of the catheter has been produced for ease of manipulation and increases ease of syringe fixation. No stopcock is required for the arterial procedure.

Gensini catheter. This catheter is developed specifically for the percutaneous technique. It has a short tapered distal tip. There are 3 sets of laterally opposed side openings within 1.5 cm of the open tip. The distal opening is smaller than the lumen of the catheter to provide a close fit for the spring guide when it emerges from the tip.

Goodale-Lubin catheter. The Goodale-Lubin end hole, side holes catheter has the same basic woven Dacron construction as the Cournand, with the addition of two laterally opposed woven eyes close to the distal tip to allow lateral as well as direct flow from the tip. The standard Cournand catheter is used for obtaining blood samples and pressure data in the routine catheterization of the right heart and coronary sinus.

Jameson electrode probe, Platinum. This probe consists of a special steel core, tipped with a platinum electrode and insulated with a woven Dacron and a special plastic coating. It can be passed through a 19-ga thin-wall needle (#9125), and/or a 5 French Lehman 5400 catheter, for hydrogen ion and ascorbic acid dilution studies in the detection of intracardiac shunts.

This platinum probe affords electrode mobility, reliability, and use with small lumen catheters.

Lehman catheter. The Lehman is a thin-wall end-hole catheter with a larger lumen and greater flow capacity than the comparable size Cournand catheter. The curve in the distal tip of this catheter is rounded. The catheter is constructed of woven Dacron with a special radiopaque coating.

Myler™ right heart catheter. This multipurpose electrode catheter is used for sampling, pressure monitoring, dye injections, wedge pressure, and atrial pacing. The electrodes are positioned 11 cm and 12 cm from the distal tip.

NIH catheter. The NIH catheter is a thin-wall catheter constructed with a smooth-bore nylon core reinforced with woven Dacron in sizes 5 French through 8 French. The distal tip of the NIH is closed, with six round eyes arranged in three laterally opposed pairs within the first centimeter of the tip. This catheter is used primarily for angiographic studies of the aortic arch and left ventricle in the diagnosis of mitral and/or aortic insufficiency as well as aortic aneurysms.

Percutaneous catheter introducer (Cordis). This is a 10 cm sheath assembly, incorporating hemostasis values and a 22 cm side-port extension with a Luer fitting and cap, a stainless-steel mini-guide wire 45 cm long with a 0.038 in. diam., and a tapered 20 cm vessel dilator.

Positrol Sones coronary catheter. This catheter is constructed the same as the regular Sones catheter, except that a fine stainless-steel mesh has been incorporated in the wall which results in positive longitudinal torque control from proximal Luer-Lok to distal tip. The distal tip curve can be either 1 in. or 1½ in.

Sones catheter. The Sones is a woven Dacron catheter. Type I has a tip length of 1½ in., while Type II has a 1-in. tip. The tapered tip has four woven eyes arranged in two laterally opposed pairs within 7 mm of the open tip. Catheter sizes 7 French and 8 French have the same 7 French lumen. The 8 French size has a heavier wall, and therefore provides a more rigid shaft and greater radiopacity. This catheter is designed for selective catheterization of the coronary vessels and can be used percutaneously with the 0.033 in. spring guide.

Swan-Ganz catheter. The Swan-Ganz is an especially constructed balloon-tipped double lumen catheter. Its use is an effective method of measuring pulmonary artery and pulmonary wedge pressures. The soft pliable body allows the force of the blood flow on the balloon to propel the catheter into the pulmonary artery. The soft, rounded balloon covers the catheter tip when inflated to capacity and distributes force over an increased area. This construction feature minimizes the occurrence

of premature ventricular contractions during passage of the catheter. Position of the catheter tip is determined by pressure monitoring. Accurate wedge pressures are obtained without catheter manipulation by inflating the balloon to occlude a pulmonary artery branch. The Swan-Ganz is also available in some laboratories as: a triple lumen catheter, which permits the additional monitoring of right atrial pressure; a bipolar pacing catheter; and a thermodilution catheter for measurement of cardiac output.

Zucker catheter. The Zucker multi-purpose catheter is constructed of woven Dacron, and incorporates two platinum electrodes--one at the distal tip; and a second, 1.5 cm proximal to the first. The lumen opens at the distal tip and through two lateral openings in the distal electrode. This catheter is used for blood oximetry sampling and pressures, for contrast media injections and indicator dyes, for recording intracardiac ECG's, and to provide a bipolar electrode for cardiac pacing.

Care of Catheters Postprocedure

In the Laboratory

1. Wipe off and flush catheter thoroughly, using clean water. Be sure the lumen is patent and free from plugs. Flush through catheter with at least 50 cc water.
2. Flush with diluted solution of Detergicide and water (1 capful to 1 basin of water), using 30 cc.
3. Soak in basin of Detergicide solution for ½ hr.
4. Attach to wall flusher, and flush with cold water for ½ hr.
5. If catheter has no lumen, rinse with cold water, wipe off with Detergicide, and soak in Detergicide for ½ hr.

In Central Supply.

1. Rinse with distilled water.
2. For electrode catheters, check each electrode with ohmmeter.
3. Using distilled water, inject 30 cc through the lumen.
4. Using a clean, dry 30 cc syringe, inject air through the lumen until the lumen is completely dry.
5. Dry off completely, using dry 4 x 4 in. gauze sponges, feeling for cracks and abrasions. Use magnifying glass to check tip.
6. Use any required stylettes, attach label-holder, and seal in polyethelene tubing.

7. Gas sterilize, using manufacturer's instructions.

8. Aerate for the required time--at least 12 hr.

9. Place in proper slot in the catheter cabinet.

Catheterization Trays

Trays and special equipment which are prepared for the performance of cardiac catheterization procedures are shown in Figures 14-18.

Summary

The supplies and equipment available for use in this laboratory have been introduced in this report section. The descriptions should familiarize newly assigned personnel with the primary characteristics of various cardiac catheters. Although catalog numbers are subject to change, those given here could be useful in ordering.

Shown in figures in the closing pages of this section are the materials used in this laboratory to set up for various cardiac catheterization procedures.

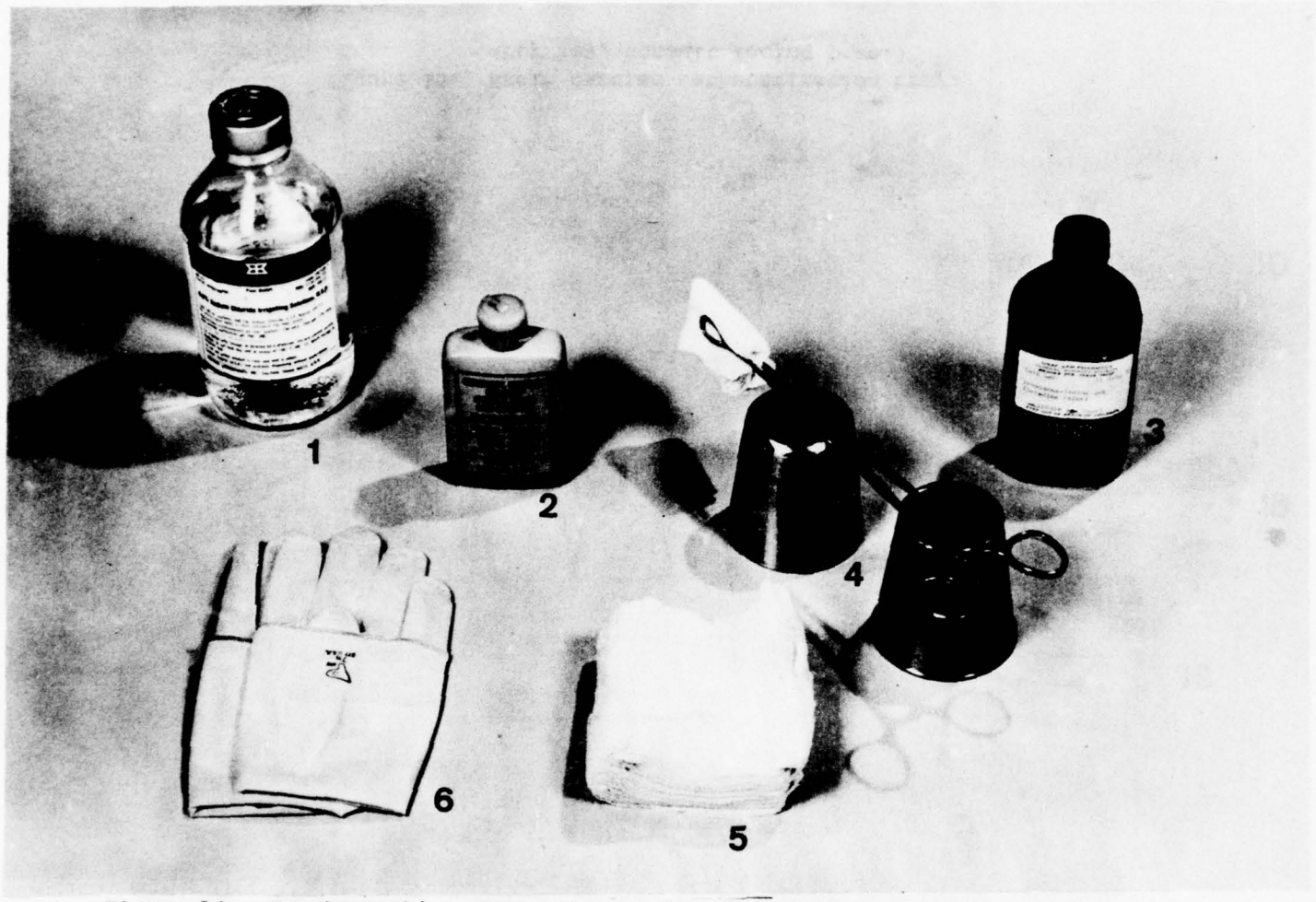

Figure 14. Surgical skin preparation equipment.
[1 = sterile normal saline irrigating solution;
2 = Betadine detergent, povidone-iodine 7½%, for surgical scrub;
3 = Betadine paint, povidone-iodine 10%;
4 = contents of prep set: 2 solution cups and a sponge forceps;
5 = 4 x 4 in. gauze sponges; and
6 = disposable surgical gloves.]

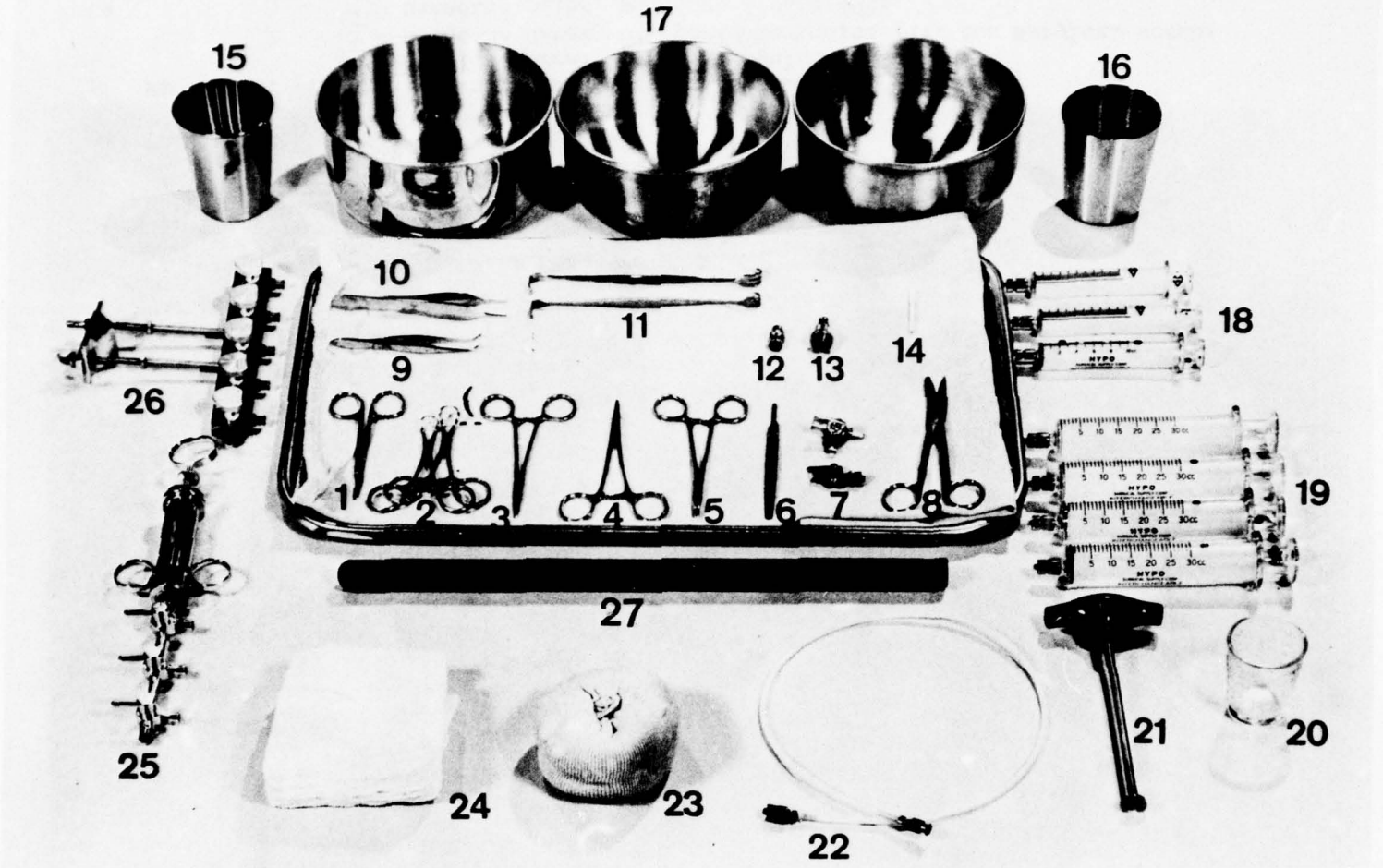

Figure 15. Basic cardiac catheterization tray.
(For key, consult facing page.)

-- Key to Figure 15 --

NOTE: Numbers within brackets indicate how many of each item must be on the tray.

1. Curved iris scissors [one]
2. Towel clips [eight]
3. Brown needle-holder [one]
4. Straight Halsted mosquito hemostats [three]
5. Curved Halsted mosquito hemostats [three]
6. A #9 surgical knife handle [one]
7. One-way and three-way stopcocks [one each]
8. Mayo general suture scissors [one]
9. Utility eye forceps [one]
10. Adson tissue forceps [one]
11. Senn retractors [two]
12. Rotating adapters [two]
13. Male-to-male adapters [two]
14. Vein pick, catheter introducer [one]
15. Solution cup (for local anesthetic agent) [one]
16. Solution cup (for contrast medium) [one]
17. Solution bowls (for heparinized saline and wet sponges) [three]
18. Luer-Lok syringes, 10 cc, glass [three]
19. Luer-Lok syringes, 30 cc, glass [four]
20. Medicine glass (for heparin) [one]
21. Handle for disposable Cordis dye injector syringes [one]
22. Teflon pressure line [two]
23. 3 in. rolled stockinette, 36 in. long [two]
24. 4 x 4 in. gauze sponges [approximately 100]
25. Socorex glass syringe, 10 cc, and USCI manifold with Teflon cores [one each]
26. Paley manifold with 5 hubs [one]
27. Mounting pole for Paley manifold [one]

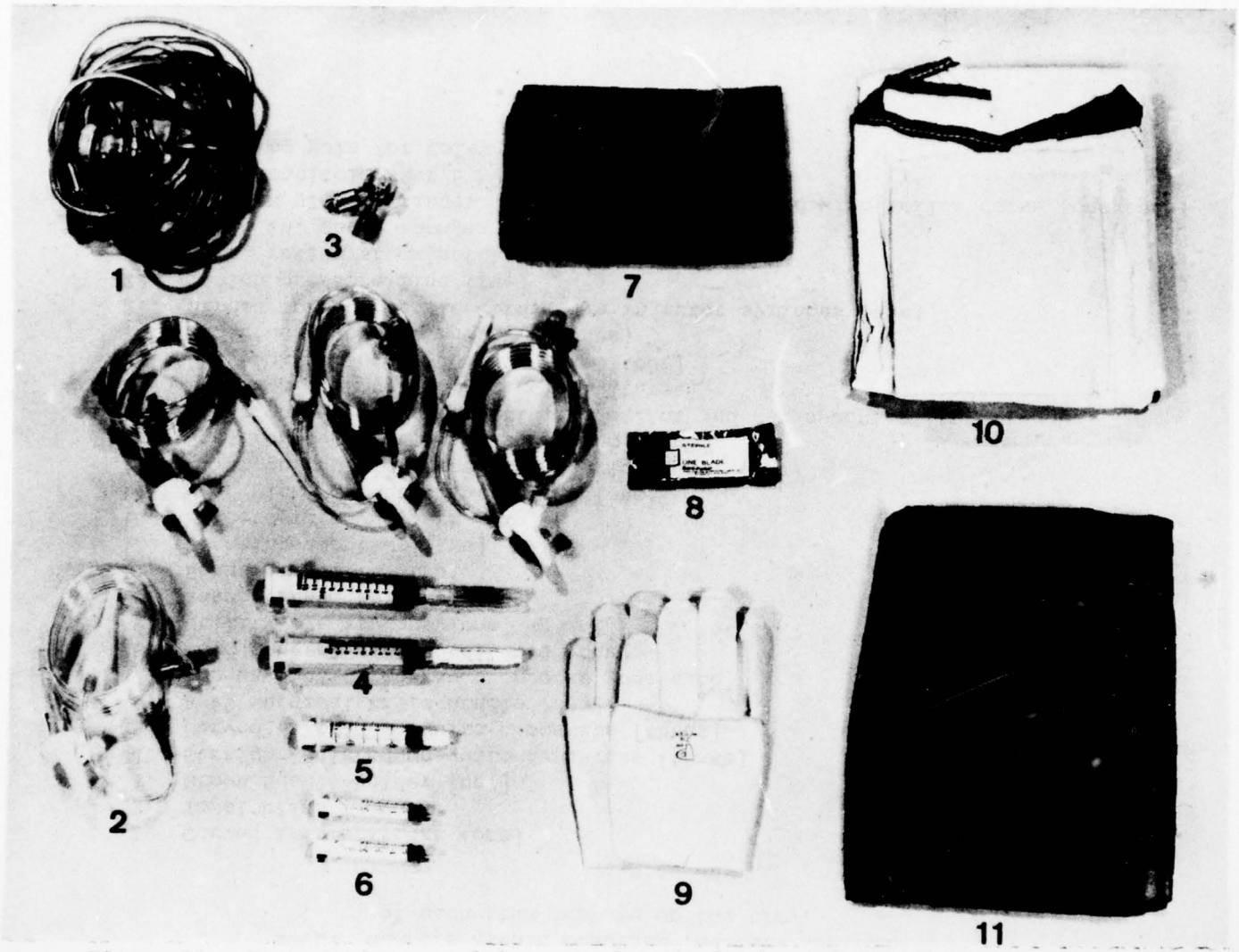

Figure 16. Items to be opened for use with the basic catheterization tray.
[For key, consult facing page.]

-- Key to Figure 16 --

NOTE: Numbers within brackets indicate how many of each item must be on the tray.

1. Pressure transducer cable [one]
2. Sterile intravenous infusion sets [four]
3. Pressure dome and hub for transducer [one]
4. Disposable 10 cc syringes, for administration of local anesthetic (one with a 26 ga needle, and one with a 20 ga needle)
5. Disposable 5 cc syringe [one]
6. Disposable 3 cc syringes [two]
7. Nonabsorbent disposable drape towels [eight]
8. A #11 surgical knife blade [one]
9. Disposable surgical gloves [one pair for each participating cardiologist]
10. Disposable surgical gown and absorbent towel [two]
11. Nonabsorbent disposable drape sheets [three]*

*We are currently using a single nonabsorbent disposable drape sheet with bilateral circular fenestrations for the percutaneous approach.

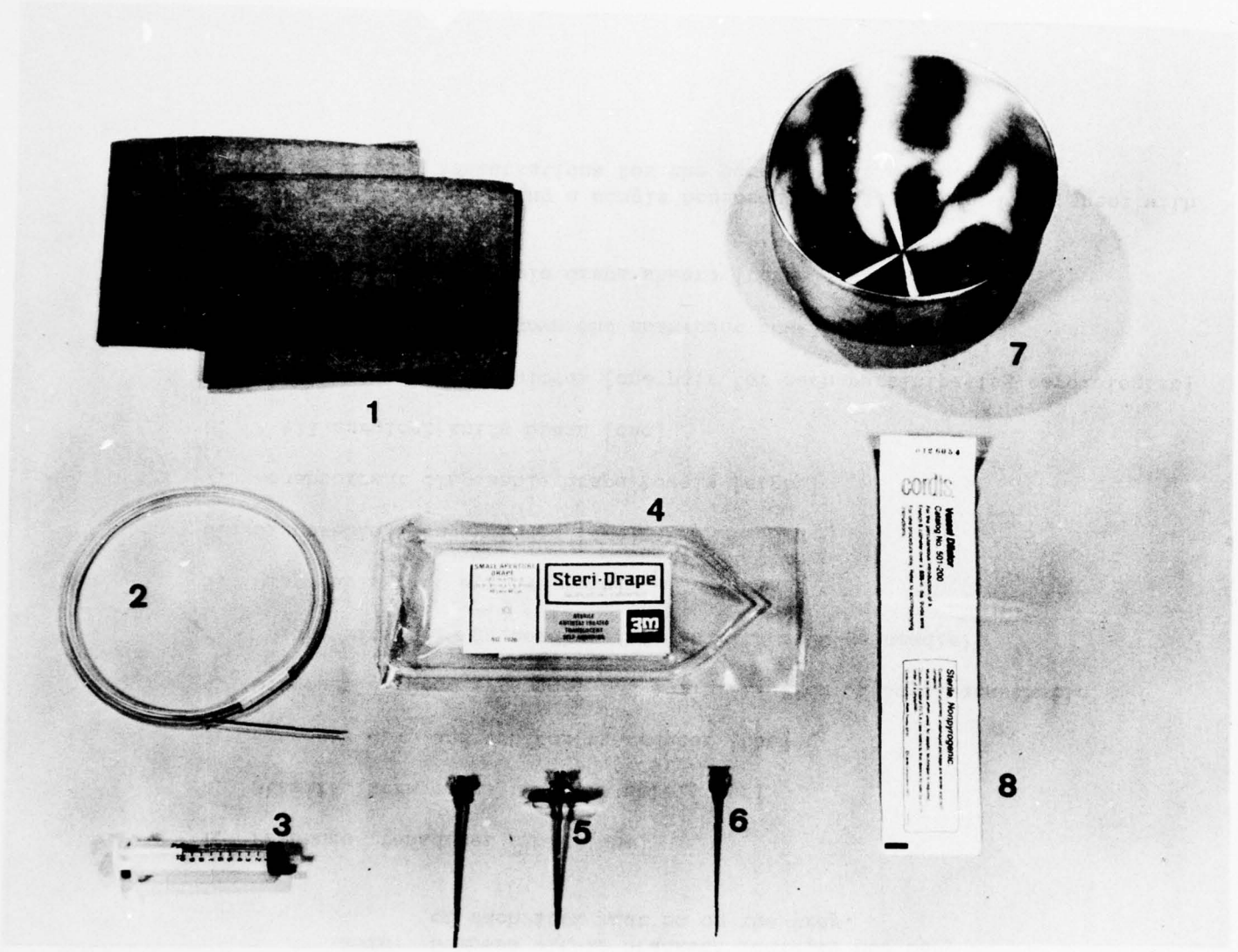

Figure 17. Percutaneous approacn items to add to the basic cardiac catheterization setup.
[For key, consult facing page.]

-- Key to Figure 17 --

NOTE: Numbers within brackets indicate how many of each item must be on the tray.

1. Nonabsorbent disposable drape towels [four]
2. Teflon-coated guidewire, 0.038 in. diam., 145 cm long, in a holder [one]
3. Disposable 10 cc syringe [one]
4. Small aperture Steri-Drape, self-adhering [two]
5. Reusable Cournand needle and stylette [one of each]
6. Reusable thin-wall needle, 18 ga [one]
7. Sponge basin [one]
8. Disposable vessel dilator [one]

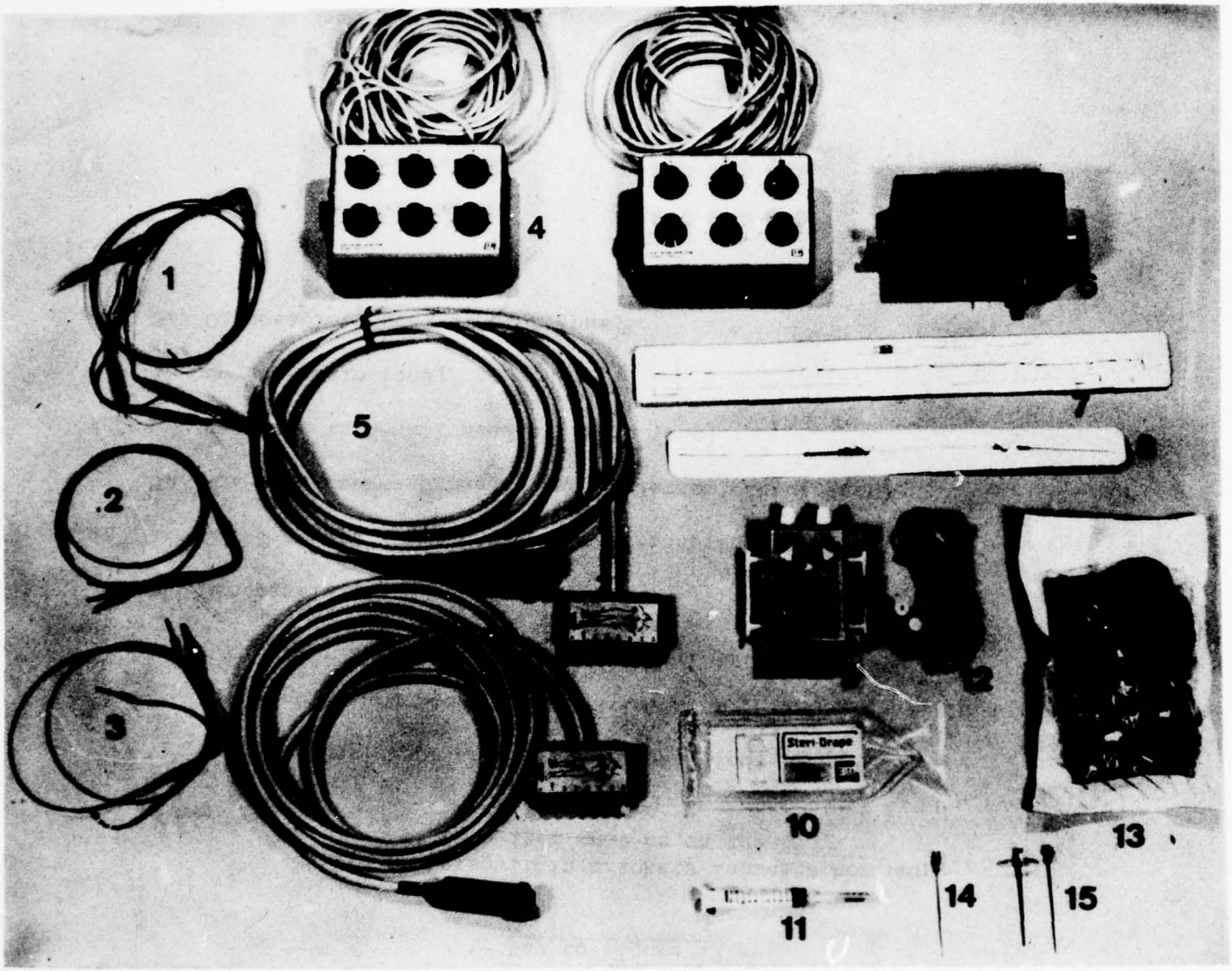

Figure 18. Additions to the basic cardiac catheterization setup, as necessary for a His bundle electrogram or other electrical study.
[For key, consult facing page.]

-- Key to Figure 18 --

NOTE: Numbers within brackets indicate how many of each item must be on the tray.

1. Hexapolar catheter, 6 French x 120 cm [one or more]
2. Quadrapolar catheter, 6 French x 100 cm [one or more]
3. Tripolar catheter, 6 French x 100 cm [one]
4. Electrode selector junction box (unsterile) [two]
5. Frank His cable (unsterile) [two]
6. Isolation unit for Bloom Stimulator (unsterile) [one]
7. Cordis Catheter Sheath Introducer [one]
8. UMI Percutaneous Catheter Introducer [two]
9. Medtronic pacemaker with synchronous and demand capabilities (unsterile) [one]
10. Small Aperture Steri-Drape, self-adhering [two]
11. Disposable 10 cc syringe with 23 ga x 3/4 in. needle [one]
12. Cable for Medtronic pacemaker [one]
13. His study and/or electrical study connecting cables [twelve]
14. Reusable thin-wall needle, 18 ga [one]
15. Reusable Cournand needle and stylette [one each]

SPECIFIC PROCEDURE GUIDELINES

Introduction

Because the scope of this publication is limited, only a few specific procedure guidelines are presented. Details for the operation of each piece of equipment will be found in the respective operating instructions available in the cardiovascular laboratory office.

A computerized automatic injecting system is used for angiographic studies, so procedures for preparing the Viamonte and Cordis Injectors are described here. A brief discussion of cardiac output determination is followed by an outline of requirements for the Fick technique and a fairly detailed orientation to the Cardiogreen technique.

Procedure for Loading the Viamonte Injector

This procedure, for loading the Viamonte Injector, is usually performed by the circulating technician as part of the preparation for an angiographic case:

1. Wash and dry hands.
2. Don sterile gloves.
3. Obtain a Viamonte syringe from the sterile catheterization set.
4. Fill the syringe by aspirating the specified contrast medium using an 18 ga needle, or extension tube, or by pouring the dye directly into the syringe barrel. If the pouring method is used, be sure the lip of the original container is free of contaminants or sediment before pouring.
5. Remove all bubbles from the filled syringe.
6. When placing the syringe in the Injector, be sure the sterile cap covers the syringe tip, and that the syringe tip does not touch the sides of the Injector.
7. After locking the syringe in place, place a sterile drape over the arm of the Injector to protect the loaded syringe from airborne and contact contamination.
8. Plug in the Injector, and set the controls on "Stand By" until the unit is needed (97).

Procedure for Loading the Cordis Injector

In this laboratory, the Viamonte is the primary injector and the Cordis is maintained for backup capability. Should the Cordis Injector be required, it is prepared for use by the circulating technician before an angiographic procedure. The following preparations are necessary:

1. Connect the external ground for the Injector to the ground receptacle on the x-ray table.
2. Plug in the Injector, place the selector switch on "FILL" position, and extend plunger rod completely, using the plunger switch (located just above the injector switch).
3. Wash and dry hands.
4. Thoroughly wipe plunger rod with alcohol sponge while retracting it back into the Injector.
5. Using aseptic technique, unwrap reusable Cordis syringe, plunger plug, and extension tube from their sterile packages.
6. Don sterile gloves.
7. Place plunger plug securely into the syringe and attach the extension tube.
8. Place the syringe in the Injector, making sure connections are secure.
9. Extend the plunger completely into the syringe (as far as it will go).
10. Without contaminating the lip, open a bottle of contrast medium.
11. Tip the Injector head so the syringe points downward, and direct the extension tube into the contrast medium, being careful not to contaminate the tube.
12. Use the plunger switch to retract the plunger and draw the contrast medium into the syringe. Retract completely.
13. After withdrawing the extension tube from the bottle, turn the Injector head so the syringe points straight up.
14. Clear the syringe of all air bubbles.
15. Return Injector head to horizontal position and cover the syringe and extension tube with sterile nonabsorbent drape until needed.
16. Be sure the heating element does not exceed 40°C. Should the temperature gage register above 40°C, switch the power off temporarily.

Operation of the Cordis Injector

The following procedure is included because, although the Cordis Injector is rarely needed in this laboratory, operators should be familiar with its operation:

1. Maintain Injector switch on "FILL" position until actually ready to inject. Then turn switch to "INJ" setting.

2. Set the volume control dial to the total amount of contrast medium desired by the cardiologist.

3. Be sure the "DELAY/sec" knob setting is on "INJ," unless spot films or a delayed left ventriculogram are being done.

4. Set the "CATH ID/mm" control to the actual internal diameter of the catheter being used. [See "NOTE" below.]
   a. For Sones procedures, the ID is usually 1.0 mm.
   b. For Judkins procedures, the ID is usually 1.4 mm.

5. Dial the "CATH/Cm" knob to the setting that corresponds with the length of the catheter being used.

6. Adjust the pressure setting to that which the cardiologist desires, usually between 300 and 400.

7. The "TRIGGER" button or the "SCOUT" pedal may be used for jogging under fluoroscopy. To jog, the Injector switch must be on "INJ." To aspirate, the Injector switch must be on "FILL."

[*NOTE: The internal diameter (ID) setting and the pressure setting determine the rate of injection (ml/sec).*]

Cardiac Output--An Overview

A basic hemodynamic characteristic of the cardiovascular system is the amount of blood the heart pumps through the body, or cardiac output. Stroke volume and heart rate are the components of cardiac output. The amount of blood the heart pumps out during systole is stroke volume; and the rate is the number of systoles per minute. The capability of the heart to perfuse the tissues with blood may be determined by measuring the cardiac output in liters per minute.

The measurement of cardiac output in the cardiovascular laboratory is based on the Fick principle: the total uptake or release of a substance by an organ is the product of the blood flow to the organ and of the arteriovenous concentration difference of the substance. In other words, if the amount of a particular substance, like oxygen, is known when introduced into the circulatory system, the flow of blood can be determined by measuring the differences in concentration of the substance in the blood between two points in the system. Thus,

$$\text{Cardiac output} = \frac{\text{oxygen consumption (ml/min)}}{\text{arteriovenous } O_2 \text{ difference (ml/100 ml blood)}}$$

For instance, assume a patient consumes 240 ml oxygen/min. Blood measured from the pulmonary artery reveals an oxygen content of 15 ml/100 ml; and from the aorta, 19 ml/100 ml blood. Apply the formula:

$$\frac{240 \text{ ml/min}}{19\text{-}15 \text{ ml/100 ml}} = \frac{240 \text{ ml/min}}{4 \text{ ml/100 ml}} = 6000 \text{ ml/min Cardiac Output}$$

Other substances, such as dye or iced saline, may also be used similarly to ascertain cardiac output (36, 84).

Fick Oxygen Output

The actual determinations are run in the pulmonary laboratory from air and blood samples collected during cardiac catheterization. Therefore, only the collection aspect of the study is discussed here.

Special equipment needed to collect samples--

1. Douglas bag
2. One-way valve
3. Mouthpiece
4. Large clamps, to seal bag after air collection is completed
5. Nose clips
6. Iced container, for transporting blood samples
7. Two 10-cc glass Luer-Lok syringes, sterile
8. Tape or labels marked "PA" and "AO"

Procedure for sample collection--

1. Right and left heart catheterization is performed.
2. A venous catheter is placed in the pulmonary artery (PA).
3. An arterial catheter is placed in the aorta (AO).
4. The mouthpiece, one-way valve, and Douglas bag are securely joined.
5. The patient is briefed on the collection procedure.
6. The mouthpiece is properly positioned in the patient's mouth. The one-way valve is open to room air. The Douglas bag may also be clamped to insure no exhaled air is collected prematurely.
7. Nose clips are placed to insure the patient cannot breathe through his nose.
8. Allow the patient to achieve a steady state by breathing for 1½ min without collecting air.

9. Collect air for a total of 3 min.

10. Call out the time, so all team members can be aware of the proceedings.

11. At the beginning of the second minute of air collection, aspirate 10 cc blood from the PA and the AO simultaneously and during the whole minute. The electronic technician records an ECG tracing of that entire minute. One team member should call out the time in seconds, by tens, throughout blood collection and ECG recording.

12. At the end of the second minute, the blood samples should be sealed with syringe caps, labeled appropriately, and plunged into the iced receptacle.

13. After the third minute of air collection, the Douglas bag is promptly sealed, the mouthpiece and nose clips removed from the patient, and the samples transported to the pulmonary laboratory for analysis.

Cardiogreen Cardiac Output

Cardiogreen, a brand name of indocyanine green, is one substance used for an indicator dilution technique in determining cardiac output. This procedure is rarely done in this laboratory; but, because precision is vital and the process somewhat complicated, a fairly detailed discussion is given here. The following equipment is necessary [bracketed numbers indicate how many of each item should be available]:

1-2 cc syringe [one]
20-30 cc syringe [one]
3-way stopcock [one]
Cardiogreen dye (50 mg)
Harvard Pump [one]
Densitometer [one]
Densitometer curvette-sterile [one]
E for M Connector [one]
50 cc heparinized (5 cc) syringes [two]
female-female connector [one]
male-female connector [one]

In most cases, this procedure will be done during cardiac catheterization, and the patient will have a venous catheter in the central circulation (SVC, RA, RV, PA) for injecting the dye and an arterial catheter in the aorta for sampling. Information follows concerning: 1, the injection system; 2, the sampling system; and 3, the procedure for measuring cardiac output:

1. Injection System--The function of the injection system, to deliver dye in a bolus to the heart, is done by rapidly injecting the dye and instantly following it with a saline or blood flush.

a. Equipment required:

2 syringes--one small (1 to 2 ml), and one larger (30 ml)

1 three-way stopcock

b. Construction of system (Fig. 19):

The two syringes are attached to two of the stopcock connectors. The injection catheter is attached to the third stopcock connection.

c. Operation of the system:

The small syringe is loaded with an accurately known volume of dye. The larger syringe is loaded with saline. The amount of saline required will depend upon the volume of the catheter system. Sufficient saline should be used to insure that all of the dye is injected into the blood. Typical quantities of saline vary between 5 ml and 12 ml. The catheter is filled with saline from the large syringe. The system is maintained closed until ready for a dye curve. The stopcock is then opened: first, to the small syringe which is rapidly emptied; and, then, to the large one. The flush should follow the dye as quickly as possible.

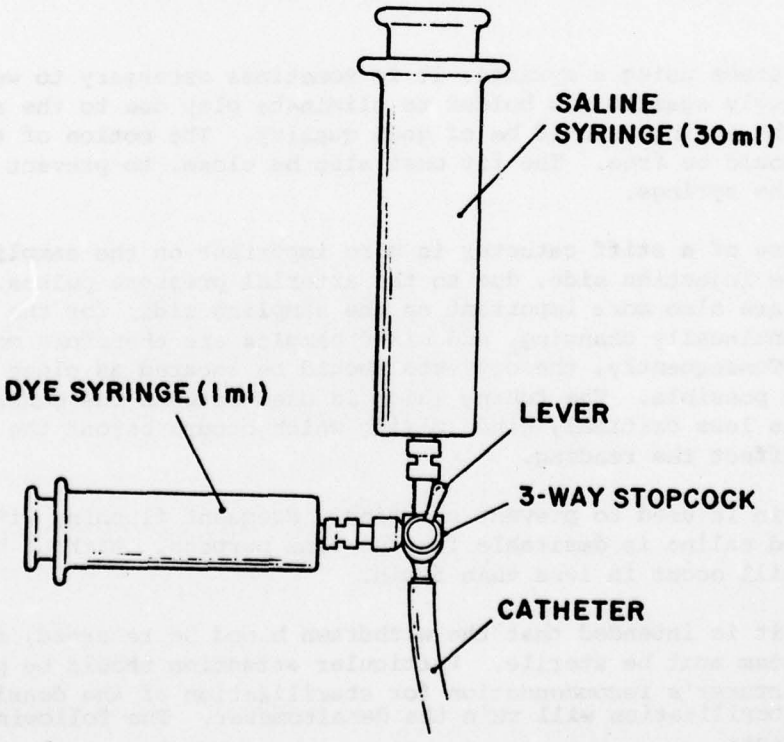

Figure 19. The design of the dye injection system.

d. Discussion:

This system has the advantage of simplicity of construction. Also, the syringe can be refilled without much difficulty.

Its main disadvantage is that the stopcock key must be turned between the dye injection and the flush. This step must be made quickly; for, if too much time elapses between the dye injection and the flush, the dye will not arrive at the heart in a bolus and the curve itself will not be accurate. It is not impossible to achieve a bolus injection with this system, but some manual dexterity is required.

2. Sampling Systems--The sampling system, since it involves more complex equipment, requires even more care than the injection system. The withdrawal system (Harvard Pump) must meet the following requirements:

The withdrawal rate must be constant. This constancy must be independent of arterial pressure. Failure to maintain the same rate during calibration (low pressure) as during dye curves (high pressure) will result in calibration error. The withdrawal should also be smooth. Not only must the motion of the mechanism be smooth, it must also be able to maintain a smooth flow against the pulsations of arterial pressure.

In systems using a syringe, it is sometimes necessary to wedge the plunger snugly against its holder to eliminate play due to the arterial pulses. The syringe should be of good quality. The motion of the plunger should be free. The fit must also be close, to prevent sucking air into the syringe.

The use of a stiff catheter is more important on the sampling side than on the injection side, due to the arterial pressure pulses. Short catheters are also more important on the sampling side; for the concentration is continually changing, and mixed samples are therefore more of a problem. Consequently, the curvette should be located as close to the patient as possible. The tubing which is used between the densitometer and pump is less critical, since mixing which occurs beyond the densitometer does not affect the reading.

Heparin is used to prevent clotting. Frequent flushing with heparinized saline is desirable for the same purpose. Without heparin, clotting will occur in less than 5 min.

When it is intended that the withdrawn blood be returned, the entire system must be sterile. Particular attention should be paid to the manufacturer's recommendation for sterilization of the densitometer. Improper sterilization will ruin the densitometer. The following steps are important:

a. Balancing and Calibration of Densitometer

Before meaningful dye-dilution curves can be made, the dye-concentration measurement and recording apparatus must be balanced, or "zeroed," and calibrated. Balancing the densitometer consists of establishing a densitometer output that represents zero, or, for repeated measurements, the starting concentration of dye. The baseline of the recorder should be set at this level. The densitometer must be balanced for each individual patient, as the optical density of blood may vary from person to person. It is also advisable to rebalance the densitometer during the course of a series of dye-dilution curves on a single patient.

The dye-dilution measurement and recording system must also be calibrated before it is used to make dye-dilution curves. This calibration is done by running blood, having a known concentration of dye, through the densitometer curvette and observing the deflection from baseline of the recorder trace. Recording papers have a linear chart gradient, the scale of which is determined by the trace representing a known concentration. The trace may be adjusted so that it falls on a line on the chart that will set a convenient scale.

b. Calibration Procedure

For calibration of the densitometer and recorder, a sample of the patient's blood with a known concentration of dye is required. No standard procedure has been established for making such a sample, and the following procedure is only a suggestion. The water used in this procedure should be the solvent that comes with the dye.

c. Making a Calibration Sample

Mix 25 mg of dye with 5 cc H_2O. The resulting solution will have a concentration of 5 mg dye/cc H_2O. Add 0.5 cc of this solution to 15.5 cc H_2O, giving a solution of 2.5 mg dye in 16 cc H_2O. Mix 0.4 cc of this solution to 10 cc of blood. This procedure will yield blood with a dye concentration of 6.2 mg/liter (2).

25 mg dye in 5 cc H_2O yields 5 mg/cc, of which
0.5 cc in 15.5 cc H_2O yields 2.5 mg dye in
16 cc H_2O, or 1.25 mg/8 cc, of which
0.4 cc in 10 cc blood yields 6.2 mg dye/liter
blood

If the sample of dye-bearing blood is prepared in the manner described, 0.4 cc H_2O must be added to each 10 cc of blood used for balancing.

d. Calibrating the Densitometer

The baseline is set by drawing whole blood through the curvette and balancing the densitometer.

Blood from the calibration sample should now be drawn through the densitometer. This step will cause the recorder trace to deflect from the baseline. The trace deflection should then be adjusted to a deflection which is convenient. For example, if the sample already described were drawn through the densitometer, a deflection of 34 mm from the baseline would mean that each millimeter deflection would represent 0.2 mg of dye. The trace would be adjusted to that deflection.

3. Procedure for Measuring Cardiac Output

a. Injection and Withdrawal

(1) Start withdrawal pump and begin withdrawal of the patient's blood. Physician will indicate volume to be withdrawn per minute. Set calibrator to withdraw this amount. If the recorder trace is not at the preset baseline, adjust the trace using the densitometer balance control.

(2) Inject dye (5 mg for adults, 2.5 mg for children, 1.25 mg for infants) dissolved in 1 ml H_2O into the patient, and rapidly follow it with a flush of either saline or the patient's blood.

(3) Dye will appear across the densitometer curvette 5 to 20 sec postinjection. The duration of the dye concentration curve will be from 10 to 30 sec. Several curves should be made, in order to insure greater accuracy in the cardiac output determination. If a curve is too small for an accurate determination of cardiac output, a larger dosage of dye may be necessary. Dosages, however, should be kept below 2 mg/kg of body weight (19).

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b. Calculating Cardiac Output

(1) Replot the dye-dilution curve on 3-cycle semi-logarithmic paper (that is, paper having an exponential scale on one axis and a linear scale on the other). A portion of the downslope of the replotted curve should be a straight line to the point where recirculation begins. Using a straight edge, extend the straight line to the baseline of the curve. If the downslope of the replotted curve is not straight anywhere along its length, it does not represent an exponential decay, and the curve is not valid.

(2) Determine the area of the curve in terms of mg/sec (horizontal axis X vertical axis). This step requires that the average concentration be found and multiplied by the number of seconds over which the curve occurs. "Read" the curve to find the dye concentration at the end of each second. To find the average concentration, add up all the concentrations, and divide by the number of concentration readings. Multiply the average concentration by the time, in seconds, over which the curve occurs. For greater accuracy, the concentrations can be determined at each 0.5 sec (Fig. 20).

Determine the average concentration of semilog plot. The concentration at each second is found from the curve. Average concentration is found by dividing the sum of individual concentrations by number of concentration "readings." Dotted line is extrapolation of straight-line downslope to account for recirculation.

(3) Divide the amount of dye injected, expressed in milligrams, by the area of the curve, expressed in $\frac{\text{mg/sec}}{\text{liter}}$. This step will give the cardiac output in liters per second. Multiply this answer by 60 to give cardiac output in liters per minute.

Example: Suppose that 5 mg of dye were injected in a patient to make a dye-dilution curve, and that the area of this curve is 50 $\frac{\text{mg/sec}}{\text{liters}}$.

Dividing 5 mg by 50 $\frac{\text{mg/sec}}{\text{liters}}$, we have:

$$\frac{5 \text{ mg}}{50 \ \frac{\text{mg/sec}}{\text{liters}}} = 0.1 \text{ liter/sec.}$$

Multiplying this amount by 60 sec/min, we have:

(0.1 liter/sec) (60 sec/min) = 6.0 liters/min, the cardiac output for this patient.

Calculating the Cardiac Output: Summary

First: Replot indicator-dilution curve on semilog paper, and extrapolate downslope at point where recirculation begins.

Second: Determine average concentration and duration time from curve.

Third: $\frac{\text{mg dye injected}}{\text{Area of curve } \frac{\text{mg/sec}}{\text{liters}}} \times 60 =$ *cardiac output in liters/min.*

This calculation can occur in the process of replotting the curve. In addition, however, calculations have been performed in which two different people, equally skilled in the method and using the same dilution curves, have obtained substantially different results. This problem is due to the fact that a judgment must usually be made as to which slope will be extrapolated.

Procedure for Cardiogreen Dye Curves

One 50 mg vial of green dye in powder form, and two 10 cc ampules of solvent, are in the manufacturer's package of Cardiogreen.

Mixing for Patient Studies--

1. Clean top of dye vial with alcohol sponge.
2. Draw 10 cc (1 ampule) of solvent up into 10 cc syringe (sterile) with 18 ga needle.
3. Remove all air bubbles from syringes.

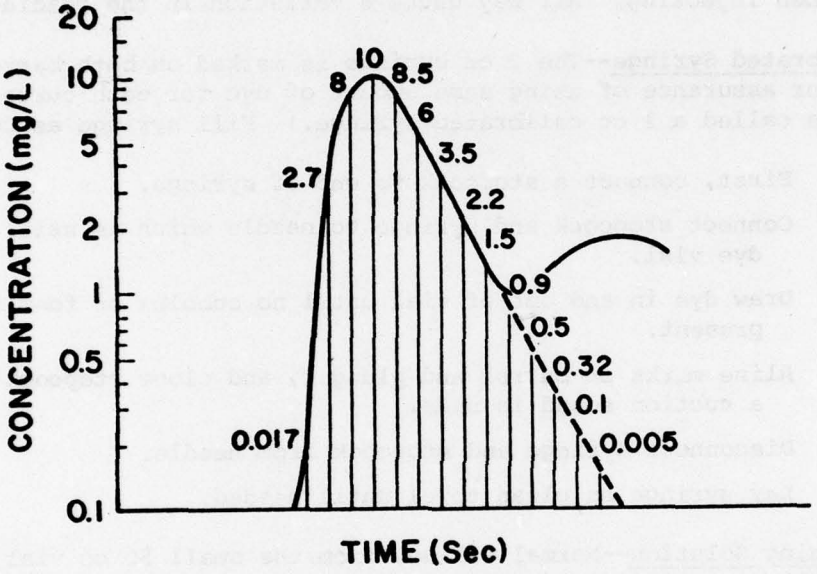

Figure 20. Calculating cardiac output.

4. Put needle into vial and allow solvent to flow into vial. Push gently, if necessary. Usually enough vacuum is in vial to draw in up to about 5 cc of solvent.

5. After 10 cc of the solvent are in vial, disconnect syringe from needle, leaving needle in vial.

6. Rotate vial gently until all dye is dissolved.

Gentle treatment, to insure less foam or air bubbles in bottle, is very important in doing dye curves. Absolutely no air should be in syringe when injecting. Air may cause a variation in the reading.

Calibrated Syringe--The 2 cc syringe is marked on both barrel and plunger for assurance of using same amount of dye for each curve. (This syringe is called a 1 cc calibrated syringe.) Fill syringe as follows:

1. First, connect a stopcock to end of syringe.

2. Connect stopcock and syringe to needle which is still in dye vial.

3. Draw dye in and out of vial until no bubbles or foam are present.

4. Aline marks on barrel and plunger, and close stopcock so that a suction sound is made.

5. Disconnect syringe and stopcock from needle.

6. Lay syringe on clean towel until needed.

Flushing Solution--Normal saline, from the small 50 cc vial, is used for flushing green dye, as follows:

1. Clean vial with alcohol sponge.

2. Use a large needle, 18 ga or 19 ga, to draw up saline.

3. Draw up 8 to 10 cc of saline in sterile 10 cc syringes. Fill about 4 or 5 syringes. This supply should be sufficient for a normal study.

4. Connect one flushing syringe to the other female tip of stopcock.

5. Push enough saline through stopcock to wash dye from stopcock, being cautious not to get dye in flushing syringes. If this problem should arise, discard the syringe and use a clean one. No dye should be in flushing syringe.

6. Put these two syringes (still connected) into a clean bowl as before.

Injecting--The operator will need the marker button for marking the Electronics for Medicine (EFM) paper, by foot pedal, at the exact moment of injection.

The cardiologist will make the connection to the catheter into which he wants dye injected. Insure the connection is secure, so as not to come loose during injection.

After the connection has been made, withdraw with flushing syringe to insure no presence of air bubbles in catheter or syringe. (Injection and flushing requires two people: one, to inject and turn stopcock; and the other, to flush. The person injecting will also mark.)

The person running the densitometer and Harvard pump (usually the circulating technician) will tell the person doing the injection (usually the nurse) when he is ready, as will the electronic technician. Always wait until the whole team is ready to begin. When everyone is ready, the person who will inject starts counting at 7--and counts: "7, 8, 9, 10."

First: At the count of "9," inject the dye.

Second: At the count of "10," turn the stopcock, flush, and mark with the foot. (A short mark--just a tap of the foot.)

Third: Each curve must be flushed with at least 6 cc of saline.

Fourth: The cardiologist will disconnect the catheter. The procedure is repeated for the next curve.

General Facts--Normally, if no dye is lost, curves and calibration may be obtained from one bottle of green dye. This amount is usually enough for a routine diagnostic study. Two bottles of Cardiogreen may be mixed ahead of time, if more than 8 curves (and a calibration) are anticipated. Mix each one in the way described, then draw all dye from one bottle into a syringe, and put it into the second bottle. This procedure is to eliminate having to do two calibrations and to insure the same concentration for all curves (36, 84).

Summary

Specific procedure guidelines for the Viamonte and Cordis Injectors have been presented in this final report section. Moreover, a brief overview of cardiac output has been followed by guidelines for sample collection for a Fick Oxygen Output study, and by a detailed discussion of the Cardiogreen Output procedure.

CONCLUSION

The successful operation of the cardiovascular laboratory is dependent upon, and limited by, the personnel who work there and by the technology available. As new people and new technical advances appear, changes should be expected and improvements in methods implemented. This report is meant as a guideline--upon which to build--for the provision of optimum care and service to those aircrew members who require cardiac catheterization as part of their aeromedical evaluation.

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A P P E N D I X A

FORMS NOS. 1 - 19

A P P E N D I X A

FORMS NOS. 1 - 19

-- FORM NO. 1 --

PHYSICIAN CHECKLIST FOR BRIEFING
CARDIAC CATHETERIZATION PATIENTS ABOUT
RISKS AND POSSIBLE COMPLICATIONS*

1. Mortality and morbidity rates
   a. Local
   b. National
2. Adverse reaction to "dye" or medication
3. Arrhythmias
4. Thrombus or embolus formation
   a. Brachial or femoral artery--this could require surgical removal of the clot and possibly the extremity
   b. Cerebral embolus--CVA or stroke with possible paralysis
   c. Coronary embolus--myocardial infarction or heart attack
   d. Pulmonary embolus--pulmonary infarction
   e. Loss of sight
5. Tamponadé
6. Hemorrhage
7. Infection
   a. Local
   b. Systemic

---

*NOTE: Every precaution is taken to prevent complications. If a serious situation were to arise, the patient would be transferred to Wilford Hall USAF Medical Center for definitive, continuous clinical management.

-- FORM NO. 2 --

POSITION DESCRIPTION

JOB TITLE: Cardiopulmonary Nurse Practitioner

Supervision Received: Chief Nurse, Internal Medicine Branch; Chief, Cardiopulmonary Function

Supervision Exercised: 90250, 70, and 90470 airmen assigned to patient care activities in the cardiopulmonary function including the cardiac catheterization laboratory and pre- and post-cardiac catheterization care areas.

Recommended Qualifications:

1. Currently licensed to practice professional nursing.
2. Master's degree in medical-surgical or cardiovascular nursing.
3. AFSC 9756 with a secondary AFSC of 9766.
4. Graduate of Flight Nurse Course.
5. Knowledge and experience in coronary and/or intensive care nursing, and experience in cardiac catheterization procedure.

Duties Performed:

1. Cardiac Catheterization Laboratory

   a. Provides precatheterization assessment of each individual patient, including the physical and mental status, vital signs, electrocardiogram. This includes checking the routine precatheterization laboratory studies and notifying physicians of any potential problem.

   b. Initiates nursing history and applicable flowsheets for the patient reflecting the physiologic and psychologic responses before, during, and after cardiac catheterization.

   c. Insures proper care and sterilization of all cardiac catheterization supplies, including the supervision and training of technicians in these tasks.

   d. Maintains, prepares, and administers emergency drugs and resuscitation equipment for immediate use; and administers all medications, both before and during the catheterization procedure.

   e. Observes and monitors care of patient continuously from his arrival at the cardiac catheterization laboratory until he is stable in the recovery area. This includes providing a safe sterile environment for the patient during the catheterization procedure, and monitoring monthly safety checklist insuring that any potential electrical hazards are reported to the Chief of the Cardiopulmonary Function immediately.

(Cont'd. on facing page)

-- FORM NO. 2 (Cont'd.) --

f. Assists the physician within the cardiac catheterization laboratory during the procedure, as indicated, including monitoring the amount of contrast media indicated and reporting the length of time the artery is open. Must be prepared to electrically defibrillate the patient if needed under the direction of the physician, and provide immediate postprocedure care including the monitoring of vital signs, ECG, incisional area, and fluid balance of the patient.

g. Plans and teaches an on-going program to educate airmen, assigned to the cardiopulmonary laboratory, in techniques utilized during the procedure as well as cardiac monitoring, arrhythmia detection, evaluation of the vital signs, evaluating of the pulses involved, and proper recording of these observations.

2. Cardiopulmonary Function

a. Plans and conducts an on-going educational program involving cardiopulmonary resuscitation to all personnel assigned to the function.

b. Coordinates research within the function and, in conjunction with the NCOIC, assigns technicians according to their skills and technical abilities.

c. Plans and conducts independent and co-investigative research studies, including assisting the cardiopulmonary physicians in writing protocols for the studies conducted within the function.

d. Monitors the research within the function to insure adherence to the protocols, and supervises the maintenance of appropriate files documenting the research conducted within the function.

e. Must be familiar with the resources of the USAFSAM ECG Library and information-retrieval system, including the monitoring of research conducted within the area.

f. Teaches in the Education Division as required.

g. Works closely with the American Heart Association and allied health personnel in setting up preventive and rehabilitative health teaching programs.

3. Other Duties

a. Participates in the Metabolic Unit activities of selection, evaluation, and care of the subjects in support of inhouse research involving human subjects.

-- FORM NO. 3 --

MEDICAL RECORD

REQUEST FOR ADMINISTRATION OF ANESTHESIA AND FOR PERFORMANCE OF OPERATIONS AND OTHER PROCEDURES

A. IDENTIFICATION

1. **OPERATION OR PROCEDURE** Right and left heart catheterization, selective coronary angiography, left ventriculography, His bundle electrocardiography, atrial pacing, output studies, electrical studies.

B. STATEMENT OF REQUEST

1. The nature and purpose of the operation or procedure, possible alternative methods of treatment, the risks involved, and the possibility of complications have been fully explained to me. I acknowledge that no guarantees have been made to me concerning the results of the operation or procedure. I understand the nature of the operation or procedure to be After numbing the area, entry of *(Description of operation or procedure in layman's language)* the large artery and/or vein in the right or left inguinal or right and/or left arm area with one or more small flexible tubes. Passage of the tubes into the chambers of the heart. Measurement of internal pressures. Injection of dye into the blood vessels and large pumping chamber of the heart, with x-ray film recordings. Record the electrical activity inside the heart, including the pacing of faster heart rates.

2. I request the performance of the above-named operation or procedure and of such additional operations or procedures as are found to be necessary or desirable, in the judgment of the professional staff of the below-named medical facility, during the course of the above-named operation or procedure.

3. I request the administration of such anesthesia as may be considered necessary or advisable in the judgment of the professional staff of the below-named medical facility.

4. Exceptions to surgery or anesthesia, if any, are: _____ *(If "none", so state)*

5. I request the disposal by authorities of the below-named medical facility of any tissues or parts which it may be necessary to remove.

6. I understand that photographs and movies may be taken of this operation, and that they may be viewed by various personnel undergoing training or indoctrination at this or other facilities. I consent to the taking of such pictures and observation of the operation by authorized personnel, subject to the following conditions:

   a. The name of the patient and his/her family is not used to identify said pictures.
   b. Said pictures be used only for purposes of medical study or research.

(Cross out any parts above which are not appropriate)

C. SIGNATURES *(Appropriate items in Parts A and B must be completed before signing)*

1. COUNSELING PHYSICIAN: I have counseled this patient as to the nature of the proposed procedure(s), attendant risks involved, and expected results, as described above.

_____
(Signature of Counseling Physician)

2. PATIENT: I understand the nature of the proposed procedure(s), attendant risks involved, and expected results, as described above, and hereby request such procedure(s) be performed.

_____ _____ _____
(Signature of Witness, excluding members of operating team) (Signature of Patient) (Date & Time)

3. SPONSOR OR GUARDIAN: (When patient is a minor or unable to give consent) I, _____ sponsor/guardian of _____ understand the nature of the proposed procedure(s), attendant risks involved, and expected results, as described above, and hereby request such procedure(s) be performed.

_____ _____ _____
(Signature of Witness, excluding members of operating team) (Signature of Sponsor/Legal Guardian) (Date & Time)

PATIENT'S IDENTIFICATION *(For typed or written entries give: Name—last, first, middle; grade; date; hospital or medical facility)*

REGISTER NO.	WARD NO.

STANDARD FORM 522
January 1973 (Rev.)
General Services Administration &
Interagency Comm. on Medical Records
FPMR 101-11.809-3
522-107

☆ U.S. GPO:1974-0-560-218/43

-- FORM NO. 4 --

CARDIOVASCULAR LABORATORY
PATIENT FLOW SHEET: PART I

NAME_____CATH DATE_____

SSAN_____RANK_____CASE (SAM) #_____

AGE_____HEIGHT_____WEIGHT_____CATH #_____

REASON FOR CATH_____

TOURS: CATHETERIZATION LABORATORY_____NURSING UNIT_____

INFORMED CONSENT GIVEN_____WITNESSED BY_____

RECORD: BROUGHT TO UNIT_____REVIEWED_____

ADMINISTRATIVE APPROVAL_____BY_____

PATIENT WILL REPORT TO NURSING UNIT AT_____HOURS ON_____

NPO_____LIQUID DIET_____

24 HOUR URINE_____CARD SORT_____EAR LOBES PHOTOGRAPHED_____

_____

LABORATORY VALUES: HCT_____HGB_____K_____

PT: Pt/Control_____PTT: Pt/Control_____

_____

PHYSICAL NOTATIONS:

CHEST X-RAY_____BLOOD PRESSURE_____P_____

HISTORY OF FRACTURES OR ARTHRITIS_____

DENTURES_____FULL_____PARTIAL UPPER_____PARTIAL LOWER_____

ALLERGIES: DYE_____DRUGS_____FOODS_____

HISTORY OF CHEST PAIN OR SHORTNESS OF BREATH_____

_____

CURRENT MEDICATIONS_____

ECG CHANGES_____

EEG FINDINGS_____

PLANNED PROCEDURE_____

HS MEDICATION_____

REMARKS_____

(Cont'd. on next page)

-- FORM NO. 4 (Cont'd.) --

PATIENT FLOW SHEET: PART II

TIME ARRIVED IN THE LAB: _____

PREPROCEDURE VITAL SIGNS: ON NURSING UNIT: B/P _____ P _____ T _____

ON ROTACOR: B/P _____ P _____

PREPARATION FOR PROCEDURE: JUDKINS _____ SONES _____ HBE _____

OUTPUT STUDIES _____ PULSES MARKED _____ BASELINE ECG _____

DEMONSTRATIONS: COUGH ROUTINE _____ DEEP BREATHING _____

PREPROCEDURE MEDICATION _____

PROCEDURE TIME STARTED _____ COMPLETED _____ TOTAL _____

ARTERIAL TIME STARTED _____ COMPLETED _____ TOTAL _____

MEDICATIONS/TIME/ROUTE/INDICATION

CATHETERS USED: _____

CONTRAST MEDIA: FIELD _____ cc; INJECTOR _____ cc; TOTAL _____ cc

FLUORO TIME _____

POSTPROCEDURE CONDITION (B/P, P, Wound Condition, Dressing, etc.)

CATH TEAM:
PRIMARY CARDIOLOGIST _____
ASSISTANT CARDIOLOGIST _____
NURSE _____
CIRCULATING TECH _____
SCRUB TECH _____
ELECTRONICS TECH _____
X-RAY TECH _____

REMARKS:

-- FORM NO. 5 --

20 CATHETERIZATION

SSAN	NAME			GRADE	CASE NUMBER
DATE OF BIRTH *(Yr,Mo,Day)*	HEIGHT *(Inches)*	WEIGHT *(Lbs)*	CATH SEQUENCE NO.	NO. FOR PATIENT	
DATE OF CATH *(Yr,Mo,Day)*	PHYSICIAN IN CHARGE	ARTERIAL CATH STARTED	ARTERIAL CATH ENDED		
		AMOUNT OF DYE USED	NO. OF ARTERIAL CATH CHANGES		

SECTION A - CORONARY RISK PROFILE

1. HAVE ANY OF THE PATIENT'S BLOOD RELATIVES HAD A HEART ATTACK, ANGINA *(Heart related chest pain)*, CORONARY ARTERY SURGERY, OR DIED SUDDENLY BEFORE THE AGE OF 65 YEARS? (YES-NO)
2. HAS PATIENT EVER BEEN TOLD HE HAS HIGH BLOOD PRESSURE? (Y-N)
3. HAS PATIENT EXERCISED REGULARLY AT ONE TIME BUT NO LONGER DOES SO? (Y-N)
4. DOES PATIENT PREFER AND REGULARLY EAT MEAT WITH VISIBLE FAT OR SKIN? (Y-N)
5. NUMBER OF EGGS EATEN PER WEEK
6. DOES PATIENT REGULARLY EAT *(at least every other day)* CHEESE OR BUTTER? (Y-N)

SECTION B - REFERRAL CONSIDERATIONS

7. REASON(S) FOR SAM REFERRAL *(One or more)*
   - 1 - FLIGHT MEDICINE
   - 2 - PSYCHIATRY
   - 3 - NEUROLOGY
   - 4 - OPHTHALMOLOGY
   - 5 - INTERNAL MEDICINE
   - 6 - CARDIOLOGY

8. CLINICAL REASON(S) FOR CARDIAC CATHETERIZATION (ONE OR MORE)
   - 01 - ABNORMAL ELECTROCARDIOGRAPHIC FINDING
   - 02 - ANGINA, DEFINITE OR SUSPECTED
   - 03 - HISTORY OF ISCHEMIC EPISODES OF INFARCTION
   - 04 - MITRAL VALVE DISEASE, SUSPECTED
   - 05 - AORTIC VALVE DISEASE, SUSPECTED
   - 06 - CARDIOMYOPATHY, OBSTRUCTIVE, SUSPECTED
   - 07 - CARDIOMYOPATHY, NON-OBSTRUCTIVE, SUSPECTED
   - 08 - PERICARDIAL DISEASE, SUSPECTED
   - 09 - RISK FACTOR PROFILE SUGGESTIVE OF CORONARY HEART DISEASE
   - 10 - OTHER

9. ELECTROCARDIOGRAPHIC REASON(S) FOR CARDIAC CATHETERIZATION *(One or more)*
   - 01 - NONE, NORMAL STUDIES
   - 02 - LEFT BUNDLE BRANCH BLOCK
   - 03 - RIGHT BUNDLE BRANCH BLOCK
   - 04 - INTERVENTRICULAR CONDUCTION DEFECT
   - 05 - SUPRAVENTRICULAR TACHYCARDIA
   - 06 - ATRIOVENTRICULAR BLOCK - 1ST, 2ND, OR 3RD DEGREE
   - 07 - SERIAL T WAVE CHANGES
   - 08 - SERIAL ST SEGMENT CHANGES
   - 09 - INFARCT PATTERNS, ECG OR VCG
   - 10 - ABNORMAL DOUBLE MASTERS, REFERRED WITH
   - 11 - ABNORMAL DOUBLE MASTERS, SAM
   - 12 - ABNORMAL TREADMILL STRESS TEST WITH HISTORY OF NORMAL ECG'S
   - 13 - ABNORMAL TREADMILL STRESS TEST WITH HISTORY OF REPOLARIZATION ABNORMALITIES
   - 14 - PVC'S, VT - RESTING OR EXERCISE INDUCED
   - 15 - ABNORMAL SEPTAL Q WAVES
   - 16 - ABNORMAL TREADMILL STRESS TEST, REFERRED WITH
   - 17 - PACEMAKER DYSFUNCTION *(e.g., sick sinus syndrome, etc.)*
   - 18 - OTHER

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(Cont'd. on next page)

-- FORM NO. 5 (Cont'd.) -- SECTION C - CATHETERIZATION PROCEDURES

10. CATHETERIZATION PROCEDURES USED *(One or more numbers)*

01 - INTRAVENOUS CATHETER, STAND BY
02 - INTRAVENOUS PACING ELECTRODE, STAND BY
03 - RIGHT HEART CATHETERIZATION
04 - LEFT HEART CATHETERIZATION, RETROGRADE BRACHIAL
05 - LEFT HEART CATHETERIZATION, RETROGRADE FEMORAL
06 - HIS BUNDLE ELECTROCARDIOGRAPHY
07 - HIS BUNDLE ELECTROCARDIOGRAPHY WITH ATRIAL PACING
08 - CARDIAC OUTPUT, FICK
09 - CARDIAC OUTPUT, CARDIOGREEN
10 - CORONARY SINUS METABOLIC STUDIES
11 - SUPINE BICYCLE ERGOMETRY
12 - CONTRACTILITY STUDIES

11. ANGIOGRAPHY COMPLETED *(One or more numbers)*

01 - RIGHT ATRIAL ANGIOGRAPHY
02 - PULMONARY ANGIOGRAPHY
03 - FORWARD ANGIOGRAPHY
04 - LEFT VENTRICLE ANGIOGRAPHY
05 - SUPRAVALVULAR, AORTOGRAPHY
06 - CORONARY ANGIOGRAPHY, SONES
07 - CORONARY ANGIOGRAPHY, JUDKINS
08 - CORONARY ANGIOGRAPHY, MIXED
09 - RIGHT VENTRICULAR ANGIOGRAPHY

12. CATHETERIZATION TECHNIQUE AND VESSEL REPAIR *(Enter appropriate number sequences)*

	A	B	C
A			
1 - ANTECUBITAL VEIN, RIGHT			
2 - SAPHENOUS VEIN, RIGHT			
3 - FEMORAL VEIN, RIGHT			
4 - BRACHIAL ARTERY, RIGHT			
5 - FEMORAL ARTERY, RIGHT			
6 - ANTECUBITAL VEIN, LEFT			
7 - SAPHENOUS VEIN, LEFT			
8 - FEMORAL VEIN, LEFT			
9 - BRACHIAL ARTERY, LEFT			
0 - FEMORAL ARTERY, LEFT			
B			
1 - CUTDOWN			
2 - PERCUTANEOUS			
C			
1 - PRIMARY ARTERIAL REPAIR			
2 - PURSESTRING ARTERIAL REPAIR			
3 - LIGATION VENOUS			
4 - VENOUS REPAIR			
5 - N/A			

13. COMPLICATIONS OF CARDIAC CATHETERIZATION *(One or more numbers)*

01 - NONE
02 - DEATH
03 - MYOCARDIAL INFARCTION
04 - VENTRICULAR FIBRILLATION
05 - VENTRICULAR TACHYCARDIA
06 - SUPRAVENTRICULAR TACHYCARDIA
07 - ATRIOVENTRICULAR BLOCK
08 - ASYSTOLE OR MARKED BRADYCARDIA
09 - ANY ARRHYTHMIA LEADING TO DISCONTINUATION OF THE PROCEDURE
10 - PROFOUND HYPOTENSION
11 - INTRAMYOCARDIAL INJECTION
12 - MYOCARDIAL PERFORATION
13 - PERFORATION OF GREAT VESSELS
14 - DIMINISHED PULSE
15 - LOSS OF PULSE WITHOUT SYMPTOMS
16 - LOSS OF PULSE WITH SYMPTOMS
17 - LOSS OF PULSE OR ARTERIAL DAMAGE REQUIRING SURGICAL REPAIR
18 - A-V FISTULA
19 - VASOVAGAL REACTION REQUIRING TREATMENT
20 - COMPLETE HEART BLOCK

SAM FORM 16

(Cont'd. on facing page)

-- FORM NO. 5 (Cont'd.) -- SECTION D - CATHETERIZATION HEMODYNAMICS

14. AORTIC PRESSURE *(mmHg)* - SYSTOLIC			
- DIASTOLIC			
15. AORTIC PRESSURE *(mmHg)* - MEAN			
16. LEFT VENTRICULAR PRESSURE *(mmHg)* - SYSTOLIC			
- DIASTOLIC			
17. END DIASTOLIC PRESSURE *(mmHg) (Before Angiography)*			
18. END DIASTOLIC PRESSURE *(mmHg) (After Angiography)*			
19. AORTIC VALVE GRADIENT *(mmHg)*			
20. MITRAL VALVE GRADIENT *(mmHg)*			
21. CARDIAC INDEX: L/MIN/M^2			

SECTION E - SUPRAVALVULAR AORTOGRAPHY

22. COMPLETED (Y-N)	

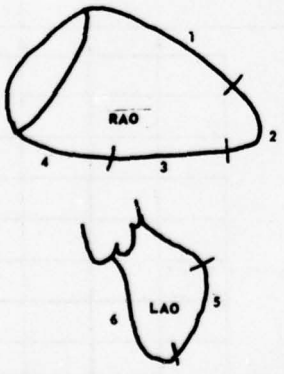
23. SUPRAVALVULAR AORTOGRAPHY *(One or more by number)*

01 - NORMAL	
02 - DILITATION OF AORTA	
03 - ANEURYSM OF AORTA	
04 - DISSECTION OF AORTA	
05 - UNICUSPID AORTIC VALVE	
06 - BICUSPID AORTIC VALVE	
07 - ANEURYSM SINUS VALSALVA	
08 - AORTIC REGURGITATION, GRADE I	
09 - AORTIC REGURGITATION, GRADE II	
10 - AORTIC REGURGITATION, GRADE III	
11 - AORTIC REGURGITATION, GRADE IV	
12 - AORTIC RUN OFF LESION, OTHER	
13 - CALCIUM, ASCENDING AORTA	
14 - CALCIUM, AORTIC VALVE	

SECTION F - LEFT VENTRICULAR ANGIOGRAPHY

24. COMPLETED (Y-N)	
25. LEFT VENTRICULAR ANGIOGRAPHY *(N=Normal, A=Abnormal. If A, complete items 26 and/or 27)*	

26. LOCATION AND DEFINITION OF ABNORMAL CONTRACTION PATTERNS *(Select appropriate codes)*



A	A	B
1 - ANTERIOR WALL		
2 - APEX		
3 - DIAPHRAGMATIC		
4 - POSTEROBASAL		
5 - POSTEROLATERAL		
6 - SEPTAL WALL		
B		
1 - AKINESIS		
2 - DYSKINESIS		
3 - HYPOKINESIS		
4 - ASYNCHRONY		

SAM FORM 16

(Cont'd. on next page)

-- FORM NO. 5 (Cont'd.) --

27. OTHER LEFT VENTRICULAR ABNORMALITIES *(One or more numbers)*
- 01 - INCREASED LEFT VENTRICULAR WALL THICKNESS
- 02 - THICKENED MITRAL VALVE
- 03 - DECREASED MOTION MITRAL VALVE
- 04 - BILLOWING MITRAL LEAFLET, ANTERIOR
- 05 - BILLOWING MITRAL LEAFLET, POSTERIOR
- 06 - MITRAL REGURGITATION, GRADE I
- 07 - MITRAL REGURGITATION, GRADE II
- 08 - MITRAL REGURGITATION, GRADE III
- 09 - MITRAL REGURGITATION, GRADE IV
- 10 - VENTRICULAR SEPTAL DEFECT
- 11 - CALCIUM, MITRAL VALVE
- 12 - CALCIUM, MITRAL ANNULUS
- 13 - INCREASED LEFT VENTRICULAR SIZE

SECTION G - CORONARY ANGIOGRAPHY

28. COMPLETED (Y-N)

29. CORONARY ANGIOGRAPHY *(N=Normal, A=Abnormal)*

30. ORIGIN OF SINUS NODE ARTERY *(Identify by segment letter or number)*

31. ORIGIN OF ATRIOVENTRICULAR NODE ARTERY

32. CIRCULATORY PATTERN
- 1 - RIGHT DOMINANT
- 2 - BALANCED
- 3 - LEFT DOMINANT

33. ORIGIN OF THE POSTERIOR DESCENDING CORONARY ARTERY(IES)
- 1 - RIGHT CORONARY ARTERY
- 2 - LEFT CORONARY ARTERY
- 3 - BOTH
- 4 - NEITHER

34. NUMBER OF POSTERIOR DESCENDING BRANCHES *(1, 2, etc.)*

35. DOES THE DOMINANT POSTERIOR DESCENDING BRANCH CROSS THE CRUX OF THE HEART? (Y-N)

36. CALCIUM *(As visualized by Fluroscopy - identify location by appropriate letter(s) or number(s)*

37. MYOCARDIAL BRIDGING *(As visualized by Angiography - identify location by appropriate letter(s) or number(s)*

38. CORONARY SPASM *(As visualized by Angiography - identify location by appropriate letter(s) or number(s)*

39. LOCALIZATION AND GRADING OF ANGIOGRAPHIC LESIONS *(If present)*

A = DISEASED CORONARY ARTERY BRANCH OR SEGMENT *(Identified by numbers or letters)*

B = LESION CODE - THOMPSON METHOD *(Identified by number)*

C = LESION CODE - SONES METHOD *(Identified by number)*

A		B		C

SAM FORM 16

(Cont'd. on facing page)

FORM NO. 5 (Cont'd.) --

40. VESSEL DISEASE SCORE

41. SONES FIVE YEAR MORTALITY ESTIMATE

42. CORONARY COLLATERAL CIRCULATION *(P=Present, A=Absent)*

43. CORONARY COLLATERAL CIRCULATION

A = THE CORONARY ARTERY BRANCH FROM WHICH THE COLLATERAL CHANNEL ORIGINATES *(Identify by number or letter)*

B = ANASTOMOTIC CHANNEL *(Identify by number or letter)*

C = CORONARY ARTERY BRANCH OR SEGMENT FILLED BY COLLATERAL FLOW *(Identify by number of segment)*

A		B		C	

44. CORONARY ANOMALIES

1 - NONE
2 - ANOMALIES OF THE CORONARY OSTIA
3 - ANOMALIES OF THE CORONARY ARTERIAL DISTRIBUTION
4 - OTHER

SECTION H - DIAGNOSIS

01 - NO EVIDENCE OF ORGANIC HEART DISEASE
02 - NO EVIDENCE OF CORONARY ARTERY DISEASE
03 - CORONARY ARTERY DISEASE, NORMAL VENTRICULAR FUNCTION
04 - CORONARY ARTERY DISEASE, ABNORMAL VENTRICULAR FUNCTION
05 - CARDIOMYOPATHY, OBSTRUCTIVE (IHSS)
06 - CARDIOMYOPATHY, NON-OBSTRUCTIVE
07 - AORTIC VALVE DISEASE, A.R.
08 - AORTIC VALVE DISEASE, A.S.
09 - AORTIC VALVE DISEASE, AR - AS
10 - MITRAL VALVE DISEASE, M.R.
11 - MITRAL VALVE DISEASE, M.S.
12 - MITRAL VALVE DISEASE, MR - MS
13 - BILLOWING MITRAL LEAFLET, ANTERIOR
14 - BILLOWING MITRAL LEAFLET, POSTERIOR
15 - PERICARDITIS, ACUTE
16 - PERICARDIAL EFFUSION
17 - PERICARDITIS, CHRONIC CONSTRICTIVE
18 - HYPERTENSIVE CARDIOVASCULAR DISEASE
19 - PULMONIC STENOSIS, VALVULAR
20 - PULMONIC STENOSIS, INFUNDIBULAR

SAM FORM 16

-- FORM NO. 6 --

CARDIAC CATHETERIZATION RECORD

Date _____

Name _____ Cath # _____ Case # _____ SSAN _____

Age _____ Ht _____ Wt _____ Body surface area _____

Procedure _____

Reason for cath _____

Diagnosis _____

SITE	PRESSURE		BLOOD O_2 CONTENT	
	Phasic	Mean	Vol %	% Sat'n
SVC				
IVC				
RA				
RV				
PA				
Wedge				
LA				
LV				
pre-inj				
post-inj				
Aorta				
Brach				
Art				

Art O_2 Cap _____

SHUNT CALCULATION (L/MIN)	
Systemic Blood Flow	
Pulmonary Blood Flow	
R → L Shunt	
L → R Shunt	
Net Shunt	
Qp:Qs	

FICK DATA	REST	EXERCISE
O_2 (ml/min/m^2)		
A-V diff (ml/100 ml)		
Syst blood flow (L/min)		
Cardiac Index (L/min/m^2)		
Heart Rate		

VALUE DATA	MITRAL	AORTIC
Pk. gradient (mmHg)		
Mean gradients (mmHg)		
Value areas (CM^2)		

REMARKS:

-- FORM NO. 7 --

FRAMINGHAM RISK PREDICTOR FORM

History and P.E.

NAME _____

AGE _____ + _____
(Yrs.) (Mos.)

Smoking History; 0 ☐ 1/2 Pk/Day ☐ 1 Pk/Day ☐ >1 Pk/Day ☐

Left Ventricular Hypertrophy: present ☐ absent ☐

Systolic Blood Pressure _____

LAB

Cholesterol _____.

Fasting Blood Sugar _____.

-- FORM NO. 8 --

JOB DESCRIPTION: CARDIOPULMONARY LABORATORY TECHNICIAN (AFSC E91670)

I. Position Title: NCOIC, Cardiovascular Laboratory

A. References

1. AFR 39-11: IMC (Interim Message Change), 20 Dec 76 - Airman Assignments (PA)
2. AFR 39-1: (1 Jun 77) Airman Classification Reg Changes
3. AFR 35-1: (25 Jul 74) Military Personnel Classification Policy
4. AFR 39-62: (15 Jul 76) Noncommissioned Officer and Airman Performance Reports
5. AFM 160-9: (18 Oct 68) Central Nursing Supply Service

B. Supervision received: OIC, Cardiac Catheterization Laboratory

C. Supervision exercised

1. Cardiopulmonary Technicians
2. Electronics Technician in the Laboratory
3. X-ray Technician in the Laboratory

D. Promotion progression potential

1. Seven level in career field
2. Promotion in grade after PFE testing
3. Next career progression: NCOIC of Cardiopulmonary Laboratory

E. Position description

As NCOIC of the Cardiac Catheterization Laboratory, he is responsible for insuring that the Laboratory functions efficiently, for maintaining all records, and for supervising its personnel. Is also involved with the actual catheterization procedure, as a scrub or circulating technician. Is responsible for seeing that supplies are up-to-date and that a 2-week supply is maintained on hand.

II. Administrative and Supervisory Responsibilities

A. Is responsible for training of all assigned medical technicians. This responsibility includes preparing, conducting, recording, and evaluating all OJT and training programs.

(Cont'd. on facing page)

-- FORM NO. 8 Cont'd.) --

B. Prepares and maintains evaluation reports on assigned medical technicians

C. Maintains proficiency by attending education programs and working in allied departments and agencies

III. Technical Duties

A. Ordering and maintenance of supplies and equipment

1. Conducts weekly inventory for outdated supplies
2. Maintains up-to-date inventory of all supplies, equipment, and files

B. Environmental safety

1. Sterilization controls

a. Supervises, conducts, and records appropriate cultures (Spordi): bi-weekly, for steam sterilization; and monthly, for gas sterilization

b. Periodically cultures cath lab and central supply areas using Rodak plates

c. Daily, damp dusts central supply--weekly, damp dusts central supply area, with Airkem solution

d. Damp dusts cath lab surfaces and equipment with Airkem solution on morning of a cardiac catheterization

e. Supervises and conducts janitorial maintenance of Cardiac Catheterization Laboratory

2. Electrical Safety

a. Insures that all equipment is maintained according to guidelines in AFR 160-3 (Prevention of Electrical Shock Hazards in Hospitals). Makes visual and palpable check of all safety plugs and equipment cords prior to cardiac catheterization.

b. Coordinates with electronics technician and Medical Maintenance regarding observed electrical hazards and periodic preventive maintenance.

c. Coordinates with x-ray support equipment for Cath Lab.

(Cont'd. on next page)

-- FORM NO. 8 (Cont'd.) --

IV. Clinical Duties

A. Support equipment preparation

1. Provides for checking all equipment
2. Emergency test procedures and notification of cath team members, day prior to procedure

B. Patient preparation

1. Provides familiarization tour of lab
2. Responsible for the following procedures--

a. Equipment check and preparation:

(1) Oxygen--including backup
(2) Suction--including catheters and masks
(3) Defibrillator--primary and backup
(4) Endotracheal intubation equipment, including tubes and laryngoscope
(5) Resuscitation equipment--Ambu
(6) Rotacor--level, stable
(7) Injector

b. Tasks supervised or accomplished:

(1) Filling ventricular injector
(2) Setup of procedure tray, to include:

(a) Catheters to be used--properly flushed
(b) Equipment needed--in operational order
(c) Medications required on field
(d) Contrast media
(e) I.V. and flush solutions

c. Admission of patient to lab, providing and/or checking the following:

(1) Steps for patient
(2) Securing of straps
(3) Taking blood pressure and heart rate, if so directed
(4) Marking of distal pulses
(5) Placement of ECG leads, if so directed

(Cont'd. on facing page)

-- FORM NO. 8 (Cont'd.) --

3. Postcatheterization care

a. Patient care:

(1) Check distal pulses
(2) Apply dressing as directed
(3) Supervise and/or assist in transfer to unit

b. Equipment care:

(1) Catheters--flush thoroughly, then soak in detergicide (20 min)
(2) Equipment--soak in detergicide

c. Clean room care:

(1) Wipe down immediate area with Airkem
(2) Wet-mop cath lab floor with Airkem solution

d. Prepare supplies for sterilization

V. Support of research activities

A. Responsible for screening and coding Coronary Risk Profile sheet used for each patient

B. Cath file responsibilities

C. Technical support to ongoing projects

VI. Additional duties

A. Assist unit with cutting and mounting of postcatheteriation and pocket ECGs

B. Assist unit with typing Cath Club Card

C. Coordinate with other departments in scheduling catheterizations

D. Assist when necessary in other departments

-- FORM NO. 9 --

CARDIOPULMONARY LABORATORY TECHNICIAN
(AFSC 91650 or 91670)

I. Supervision Received: NCOIC and OIC, Cath Lab

II. Supervision Exercised: None

III. Promotion Progression Potential

1. Seven level in career field
2. Promotion in grade after PFE testing
3. Next career progression: NCOIC, Cardiac Catheterization Laboratory

Qualifications: five level Cardiopulmonary Technician preferred
Catheterization Laboratory experience

IV. Position Description

Involved with actual catheterization procedures as a scrub or circulating technician. Responsible for seeing that supplies are up to date and that a 2-week supply is maintained on hand. Keeps up-to-date catheterization files. Responsible for general upkeep of laboratory.

V. References (refer to Form No. 8, section I.A.):

AFR 39-11
AFR 39-1
AFR 35-1
AFR 39-62
AFM 160-9

VI. Job Description:

A. Technical Duties

1. Orders and maintains supplies and equipment
2. Conducts inventory and keeps up-to-date files

B. Environmental Safety

1. Conducts bi-weekly Spordi tests on steam and gas sterilizers
2. Conducts periodic cultures in catheterization laboratory and central supply
3. Daily upkeep of central supply
4. Supervises janitorial maintenance of catheterization laboratory

(Cont'd. on facing page)

-- FORM NO. 9 (Cont'd.) --

C. Clinical Duties

1. Equipment preparation

a. Checks all equipment
b. Tests emergency procedures prior to procedure

2. Patient preparation--conduct tour of laboratory

3. Procedural responsibilities

a. Equipment check and preparation:

(1) Oxygen--backup
(2) Suction
(3) Defibrillator
(4) Intubation equipment
(5) Resuscitation equipment
(6) Rotacor
(7) Injector

b. Responsibilities during catheterization:

(1) Fill injector, or assist with filling
(2) Prepare sterile setups
(3) Assist cardiologist during catheterization as scrub technician

(a) Drape patient
(b) Pass instruments
(c) Pass catheters and guide wires
(d) Hook up Injector for L.V. gram
(e) Following a procedure: hold pressure, if required; or suture cutdown site if required

(4) Assist in transfer of patient to the Nursing Unit

D. Equipment Care After Catheterization

1. Catheter care
2. Care of instruments
3. Clean room--wipe down and mop with germicidal solution
4. Wrap and sterilize equipment

VII. Support Research Activities

A. Catheterization files
B. Technical support to ongoing projects

VIII. Additional Duties

A. Cut and mount post-cath ECG and Pocket ECG
B. Prepare Cath Club Card
C. Assist when necessary in other departments

-- FORM NO. 10 --

CARDIAC CATHETERIZATION DUTIES OF THE ELECTRONIC TECHNICIAN

1. Prepare the Electronics for Medicine equipment.

    a. Be sure the equipment is functioning properly.

    b. Load the recording paper.

    c. Balance and calibrate the transducer.

2. Work with the cardiologist preparing for special electrical studies.

3. Apply ECG leads on the patient.

    a. Be sure a good tracing is being made.

    b. Obtain a baseline tracing.

    c. Notify the nurse of the preprocedure heart rate.

4. Monitor cardiac rhythm during the procedure and notify the cardiologist of changes. ECG changes to be recognized include:

    a. Changes in the QRS complex and heart rate

    b. Sinus bradycardia and sinus arrest

    c. Heart blocks

    d. Atrial and ventricular premature beats

    e. Atrial tachycardia, flutter, and fibrillation

    f. Ventricular tachycardia and fibrillation

5. Monitor pressures during the procedure and call out catheter location by pressure indications. Pressure patterns to be recognized, and their appropriate abbreviations to be called out, include:

(Cont'd. on facing page)

-- FORM NO. 10 (Cont'd.) --

a. Aorta = "A-O"

b. Left Ventricle = "L-V"

c. Vena Cava = "V-C"

d. Right Atrium = "R-A"

e. Right Ventricle = "R-V"

f. Pulmonary Artery = "P-A"

g. Pulmonary Wedge = "Wedge"

h. Damping = to be called out whenever observed

i. Loss of Pressure = "Off Pressure"--to be called out whenever observed

6. Call out PVCs by number.

7. Record the various phases of the procedure.

8. Notify the nurse of postprocedure heart rate.

9. Check with the nurse before leaving the laboratory if the patient is still in the room.

10. Supervise monthly electrical equipment checks, and maintain records.

11. Check and record the calibration factors of the pressure transducers with a mercury manometer and check for malfunctioning monthly.

12. Report any electrical problems (such as malfunctioning equipment, current leakage, etc.) to the director and OIC of the laboratory.

-- FORM NO. 11 --

PRECATH CHECKLIST for Case #_____

THIS LIST IS TO BE ACCOMPLISHED ON THE DUTY DAY
PRIOR TO SCHEDULED CARDIAC CATHETERIZATION

Reports: Bacteriological
Floor Conductivity
X-ray Badge

For the following, check whether the item is present in sufficient levels, and operationally ready where pertinent. Use "Remarks" column, if necessary, for discrepancies; and notify the responsible party immediately for correction of the problem.

Personal Equipment (Scrub Room)	Checked	Remarks
Gowns, caps, masks		
X-ray badges		
Pocket dosimeters		
Lead aprons		
Scrub equipment		
Emergency Equipment (Cath Lab)		
Crash Cart		
Suction and catheter		
Ambu bag		
Oxygen plus backup		
Laryngoscope and bulbs		
Endotracheal tubes		
Defibrillator		
Paste		
Flashlight and bulbs		
Cardiac arrest board		
Steps for physicians		
External pacemaker		
2 sterile cords		
Emergency telephone Nos.		
Firefighting equipment		
Emergency lights		
Cath Lab Equipment for Case		
Room lights		
Patient steps		
Armboard		
BP cuff, stethoscope		
Flashlight		
Kidney basin, cups		
Dressing Supplies		
Sterile gauze, tape		
3 in. Ace, elastoplast		
Neosporin Ointment		
Scissors		

(Cont'd. on facing page)

-- FORM NO. 11 (Cont'd.) --

	Checked	Remarks
Equipment for case		
Disposable snap electrodes		
Prep sponges		
Sandpaper		
Two Mayo stands		
Single ring-stand and basin		
Kidney-shaped cath table		
Container for used needles and syringes		
Masking tape		
Linen		
Sterile		
Clean		
Prep tray		
Razor		
Blades		
Scrub tray		
Saline, Betadine paint and scrub		
Sterile equipment for case(See cards on door)		
Catheters as required		
Garbage can with liners		
Equipment for Case (Sterilizer Room)		
Catheter basin		
Catheter flusher		
Detergicide		
I.V. and non-I.V. solutions		
Pour saline		
I.V. normal saline		
250 cc		
1000 cc		
I.V. D5W		
Vascoray		
50 cc		
200 cc		
Machinery		
Harvard pump		
Main power switch		
Clock		
Contrast media warmer		
Cordis or Viamonte injector		
VR-12		
Video tape recorder		
Fluoro		
Monitor #1		
Monitor #2		
Oscilloscope		
Rotacor		
X-ray		
Cine camera case and film		
Film developer and solution		
Transducer level		
Spotlight		

-- FORM NO. 12 --

STEP-BY-STEP PROCEDURE FOR SCRUB TECHNICIAN--SETTING UP FOR A CASE

[NOTE: *Keep everything as neat and organized as possible throughout procedure.*]

1. After opening pack, use sterile pick-ups and set aside: one metal cup for 1% Lidocaine, and a medicine glass for heparin.

2. Drape table using drape sheet.

3. Scrub, gown, and glove.

4. Mount pole on table for Paley manifold.

5. Attach Paley manifold to pole and insert cores.

6. Attach pressure line and pressure transducer.

   [NOTE: *Use male-to-male adapter then rotating adapter to attach line to manifold.*]

7. Assemble dye syringe and USCI manifold, join together, and attach pressure line from Paley.

8. Flush entire assembly with I.V. heparinized saline.

9. Tighten hub, and check entire assembly for leaks.

10. Place cath tray on Mayo stand or portable table, for Judkins; for Sones, keep tray on the main table.

11. Remove any pieces that are not needed for the case.

12. Arrange each piece in order of use.

13. Put saline in two bowls--use third for 4 x 4 in. gauze only.

14. Draw up medication:
    TWO 2-1/2 cc syringes (plastic)
    Atropine 1 mg each (0.4 mg/cc)
    ONE 5 cc syringe (plastic)
    Cardiac Lidocaine 100 mg
    ONE 10 cc syringe (glass)--3500 units heparin with equal amount of saline (7 cc total)

    [NOTE: *Put each in easy-to-find place on tray (usually under cloth), but where each will not be confused with the other or with regular Lidocaine syringes.*]

15. Draw up TWO 10-cc plastic syringes of Lidocaine 1%. Place 26-ga needle on one, and 20-ga needle on the other.

(Cont'd. on facing page)

-- FORM NO. 12. (Cont'd.) --

16. Put small amount (5 cc) of heparin in guide-wire holder and check for floppy tip.

17. Make sure guide wire will fit through all required parts: Cournand needle, dilator, and catheter.

18. Make sure catheter will fit through the sheath.

19. Flush and wipe off with heparinized saline--all catheters, percutaneous needles, dilator, and sheath.

20. Ask circulating technician to put about 50 cc dye, from vial, in second metal cup.

21. Place THREE 30-cc (glass) syringes in bowl for flush; for electrical study, put ONE 10-cc glass syringe.

22. Set ONE 30-cc glass syringe aside for dye test on left ventriculogram, using dye from metal cup, if doctor wishes.

23. Place one Teflon pressure tubing on table for left ventriculogram. Hook up to injector, just prior to left ventriculogram.

24. Place catheters on table (wrap around one bowl).

25. Cover stand with drape towel.

26. Move table up to Rotacor.

27. Level transducer, using leveler as guide. Open to air for calibration, via Paley manifold.

28. Drape patient.

29. Drape x-ray head.

30. Attach light handle to spotlight.

31. Attach dye and saline lines to hand-held manifold.

32. Clear lines and syringe completely of bubbles.

33. Fill dye syringe with dye.

34. Gown and glove the doctors.

[NOTE: *Put TWO wet 4 x 4 in. gauze sponges on main table for doctors to wipe their gloves.*]

35. GO! Anticipate the doctor's needs, and stay alert throughout the procedure.

-- FORM NO. 13 --

CIRCULATING TECHNICIAN--DUTIES

1. Damp-dust equipment and flat surfaces in lab, using Airkem solution.

2. Select supplies needed for the procedure.

3. Working with the scrub technician, set up instrument table and prep sets using sterile technique.

4. Assist scrub technician with donning sterile gown and gloves.

5. Fill the dye syringe, make settings, and operate the Viamonte Injector according to the doctor's orders.

6. Greet patient and assist him onto the Rotacor.

7. Secure patient to the Rotacor.

8. Check the shave prep for adequacy.

9. Mark pulses, instruct patient regarding deep breathing and coughing, and record pulse and blood pressure if so directed.

10. Perform surgical patient scrub for 5 min, using the right brachial, and right and left inguinal areas.

11. Assist scrub technician with proper sterile draping procedures of all three potential operative sites.

12. Assist in draping the x-ray tube.

13. Assist physician in gowning procedures by proper adjustment and tying of sterile gown.

(Cont'd. on facing page)

-- FORM NO. 13 (Cont'd.) --

14. Handle the panning action of the cath table.

15. Be responsible for all needed supplies used during the procedure.

16. Watch for and report breaks in aseptic technique.

17. Monitor patient's ECG when not otherwise occupied.

18. Assist with preparing patient for transfer:

    a. Remove drape materials.

    b. Clean skin.

    c. Apply dressing.

    d. Disconnect and remove leg ECG electrodes.

    e. Record postprocedure heart rate and blood pressure, if so directed.

    f. Notify Nursing Unit when patient is ready for transfer.

19. Assist with transfer of patient from Rotacor to stretcher, and from stretcher to his bed on the Nursing Unit.

20. Working with the scrub technician, prepare the lab for the next procedure, or perform terminal cleaning duties.

-- FORM NO. 14 --

CARDIOVASCULAR NURSE'S RESPONSIBILITIES--DAY PRIOR TO CATH

Insure that the following are accomplished:

1. The patient's record is obtained and reviewed.

2. The precath checklist is completed, supply levels are adequate, and equipment is operational.

3. The cardiologist is consulted for his equipment and catheter preferences.

4. Emergency equipment and medication levels, including controlled drugs, are checked personally by the nurse.

5. The patient is briefed by his primary cardiologist regarding possible risks inherent in the procedure, and receives a copy of the orientation booklet.

6. The secretary types the identification sections for a cath chart with a sequence number assigned from the log book.

7. The cardiologist completes the following:

   a. Precath note (Standard Form 600)

   b. Doctor's order sheet (SAM Form 81)

   c. Sign his portion of consent form (Standard Form 522)

8. The x-ray technician and electronic technician are notified of the impending procedure.

9. The Nursing Unit technicians are notified of the procedure, the time the patient is to report, and the areas to be prepped.

10. Three sheets of "Nursing Record" forms (SAM Form 96) and one patient's valuables record ("Subject's Deposit Certificate": SAM Form 265) are attached to a Nursing Unit clipboard.

11. The clinical laboratory is notified of the procedure, so precath lab work can be accomplished.

(Cont'd. on facing page)

-- FORM NO. 14 (Cont'd.) --

12. The patient is briefed, to include the following:

    a. The patient has read the orientation booklet

    b. Risks and possible complications have been discussed

    c. Paperwork is initiated:

        (1) Catheterization Data Sheet (SAM Form 16), Section A
        (2) Patient Flow Sheet, Part I
        (3) Consent Form (SF 522), in detail, witnessed

    d. The patient is introduced to key personnel:

        (1) Second cardiologist, if possible
        (2) Cath Team technicians
        (3) Nursing Unit personnel

    e. The patient is oriented to (or tours) the cath lab and the Nursing Unit

    f. H.s. sedation (Dalmane 30 mg) is offered to the patient.

    g. Precath routine is reviewed, to include:

        (1) Precath lab work
        (2) Shave prep by Nursing Unit personnel
        (3) Life-style interview and earlobe photographs
        (4) Regular evening meal
        (5) H.s. sedation
        (6) NPO at midnight, or other dietary restriction
        (7) Reporting time

13. The patient's cath chart is completed, to include results of the following:

    a. EEG results

    b. Chest and KUB x-ray reports

    c. Precath lab findings: Hgb, Hct, K+, PT, PTT

    d. Xeroxed copy of baseline ECG

14. The dietician is notified of the procedure.

15. Aeromedical clearance for the procedure through the Flight Medicine Branch, with an order reading: "No aeromedical contraindication to cardiac catheterization."

-- FORM NO. 15 --

CARDIOVASCULAR NURSE'S CARDIAC CATHETERIZATION CHECKLIST

A. Before the patient arrives in the laboratory, insure that the following are accomplished:

1. The patient is greeted on the Nursing Unit, and his valuables are secured.

2. Cath team members don appropriate apparel.

3. Patient's record and secured medications are taken to the laboratory.

4. The main power-switch is activated.

5. All surfaces and equipment are wiped down with a germicidal solution and dried.

6. Clean sheets are on the Rotacor.

7. All emergency equipment is checked and prepared for use.

8. Required sterile supplies are assembled according to the planned procedure and the cardiologist's preference.

9. Contrast medium is placed in warmer.

   a. 200 cc bottle [two]

   b. 50 cc bottle [two]

10. Heparinized saline is prepared.

   a. 1,250 units heparin in 250 cc N/S soft pack

   b. 5,000 units heparin in 1000 cc N/S

      (1) One bottle for Sones

      (2) Two bottles for Judkins

11. Soft-pack heparinized saline is hung in a pressure bag.

(Cont'd. on facing page)

-- FORM NO. 15 (Cont'd.) --

12. Pacemaker and sterile cord are secured at the head of the Rotacor.

13. Programmed injector is loaded with 100 cc of appropriate contrast medium.

14. Preprocedure sedation is prepared for administration.

15. Medications for the sterile backtable are prepared: heparin, lidocaine, and atropine.

16. Basin, and wet sponges to moisten the patient's lips, are prepared.

17. Transducer cord is connected, and the cord number is recorded for proper calibration with the electronic monitoring equipment.

18. Heparinized saline for the field is hung.

19. Intravenous solution of D5W (250 cc) is prepared for use with a large Intracath if the cardiologist so desires.

20. Prep sets and solutions are prepared.

B. Upon the patient's transfer to the laboratory, insure that the following are accomplished:

1. The patient is accompanied to the laboratory by his Nursing Unit nursing notes.

2. Patient is instructed to stop in the latrine to empty his bladder.

3. After his shirt is removed, patient is assisted to the Rotacor and reminded of its narrowness.

4. Patient's pajama bottoms are removed, and he is secured to the Rotacor with three Velcro straps.

5. Blood pressure and pulse rate are checked and recorded; peripheral distal pulse sites are marked.

6. If angiography is to be performed, the patient is instructed in and demonstrates proper deep breathing and effective coughing technique.

(Cont'd. on next page)

-- FORM NO. 15 (Cont'd.) --

7. Video-taping equipment is prepared, and film leader is run.

8. With the Rotacor level, the transducer leveler is alined with the patient's mid-axillary line.

9. Skin is prepared and disposable electrodes are placed on the patient.

10. The shave prep is checked.

11. Preprocedure sedation is administered; and intravenous line is instituted, if indicated.

12. Surgical skin preparation is accomplished for all potential catheter insertion sites.

13. Sterile instrument table is moved into position.

14. Extraneous room lights are turned off.

15. Sterile transducer is leveled, and the leveler removed.

16. Patient is draped appropriately, following principles of aseptic technique.

17. Sterile handle is attached to the spotlight.

18. The x-ray tower is draped.

19. Dye and heparinized saline lines are connected and checked for bubbles.

20. Manifold is checked for leaks.

21. Cardiologists are assisted with their sterile attire.

C. During the procedure, accomplish the following:

1. Reassure and carefully observe the patient.

2. Constantly observe the cardiac monitor and vital signs. After coronary injections, notify the patient to cough if marked bradycardia occurs.

(Cont'd on facing page)

-- FORM NO. 15 (Cont'd.) --

3. Administer and record use of medications (i.e., atropine, heparin, coronary vasodilators, etc.).

4. Record arterial and procedure times.

5. Record type, size, and number of catheters used.

6. Control the tower and room lights.

7. Control intravenous infusion and record amount absorbed.

8. Observe contrast medium level, and record total amount used. Remind the cardiologist when the amount used approaches the recommended maximum for the patient's weight.

9. Maintain the saline-flush pressure bag.

10. Monitor and correct any breaks in aseptic technique.

11. Inform the electronic technician of patient's position and coronary artery injected (i.e., "RAO - left").

12. Obtain and record postcatheterization vital signs.

13. Assist with dressing application.

14. Instruct patient regarding arm and/or leg use, and importance of fluid intake.

15. Supervise transfer of patient to the Nursing Unit.

16. Obtain postcatheterization orders from the cardiologist.

17. Give patient report to medical technicians caring for him.

18. Replace secured medications, and sign for those used.

19. Assist with postprocedure care, and provide on-call coverage when required.

20. Log the procedure in the record book and in the cross-reference file.

21. Notify and give patient report to the physician on call.

-- FORM NO. 16 --

CATHETERIZATION TEAM'S PRECATHETERIZATION WORK SHEET

CATH #	DATE
CASE #	NAME
	GRADE
	SSAN

REASON FOR CATHETERIZATION

CATHETERIZATION PROCEDURES

CATHETERS USED

DOCTORS

RESULTS OF CATHETERIZATION

--FORM NO. 17 --

PREPARATION PROCEDURE FOR CARDIAC CATHETERIZATION

1. Check to see that all hair has been removed from the areas to be prepped. Touch up, as needed.

2. Using aseptic technique, open sterile prep sets containing two metal cups, pickup forceps, and 4 x 4 in. gauze

   a. Place 5 cc detergent povidone-iodine (7-1/2%) in one cup and fill with sterile saline.

   b. Half fill the other cup with povidone-iodine (10%).

   c. Add sterile hand towel to each opened set.

3. Prep skin as follows (from inner to outer aspect of area, using new sterile gauze for each circuit).

   a. Scrub for 5 min, using sterile gauze soaked with 7-1/2% detergent povidone-iodine.

   b. Blot with sterile towel.

   c. Paint, using gauze on forceps, with solution of 10% povidone-iodine, and allow to dry completely.

-- FORM NO. 18 --

LEAKAGE CURRENT MEASUREMENTS, GENERAL

AREA/LOCATION

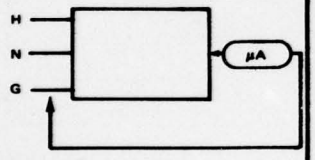
HOSPITAL

DATE

INSPECTED BY

TYPE A	TYPE B	RESULTS OK	RESULTS NO	INDEX NUMBER	NOMENCLATURE / MODEL NUMBER	TEST I RESISTANCE (mΩ)		TEST II - CURRENT (μA) GROUNDED NORMAL	TEST II - CURRENT (μA) GROUND LIFTED - POLARITY NORMAL	TEST II - CURRENT (μA) GROUND LIFTED - POLARITY REVERSED
							ON			
							OFF			
							ON			
							OFF			
							ON			
							OFF			
							ON			
							OFF			
							ON			
							OFF			
							ON			
							OFF			
							ON			
							OFF			

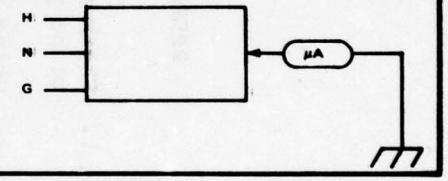
TEST I



MAXIMUM LIMITS

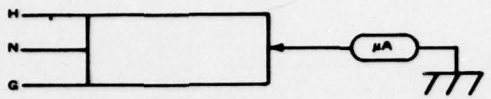
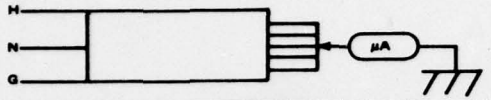
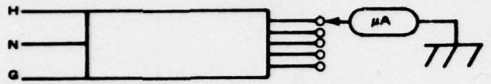
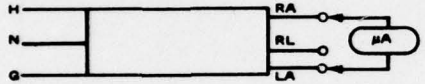
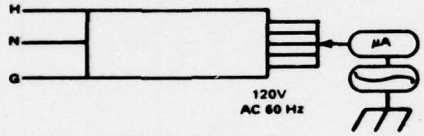
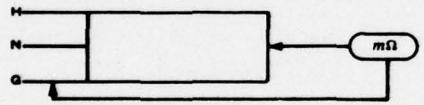
		A	B
I	Resistance	150 mΩ	150 mΩ
II	Current (Grounded)	10 μA	50 μA
	Current (Ground Lifted)	100 μA	500 μA

TEST II



DD FORM 1 JUL 75 1940 PREVIOUS EDITION WILL BE USED.

-- FORM NO. 19 --

LEAKAGE CURRENT MEASUREMENTS, EKG	AREA/LOCATION			INSPECTION DATE
HOSPITAL	MODEL	SERIAL NO.	INDEX NO.	PERSON PERFORMING TEST (Print)
INSTRUMENT MANUFACTURER	TYPE A B	GROUNDED-NORMAL POLARITY	GROUND LIFTED-NORMAL POLARITY	GROUND LIFTED-REVERSE POLARITY
		A=10μA/B=50μA	A=100μA/B=500μA	
TEST				
I 		ON		
		OFF		
		A=10μA/B=50μA	A=10μA/B=50μA	
II 		ALL		
III 		RA		
		LA		
		RL		
		LL		
		C		
LEAD 1 POSITION OR NORMAL OPERATION				
IV 		RA-RL		
		LA-RL		
		RA-LA		
W/PATIENT CABLE		A=20μA/B=500μA	REMARKS	
V 				
		A/B=150 mΩ		
VI 		mΩ	TEST RESULTS	
			SATISFACTORY	ACTION NEEDED

DD FORM 1 JUL 75 1941 PREVIOUS EDITION WILL BE USED.

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